SCIENTIFIC AMERICAN SUPPLEMENT No. 473

Scientific American Supplement, Vol XIX., No. 473.
Scientific American, established 1845.

NEW YORK, JANUARY 24, 1885.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

IMPROVED SPINNING MULE.

WALKER & HACKING, Bury, have for a few weeks past had on exhibition at their works an improved mule containing 1,000 spindles. This has been visited by a large number of people interested in the cotton trade, and from whom, we are informed, its working qualities have elicited high praise. It may be premised that the improvements are mainly to be found in the headstock. The first thing which strikes the visitor is the disappearance of one of the most prominent features of nearly all mule headstocks, as the public have hitherto known them, the celebrated radial arm and quadrant invented by Roberts. These have been substituted by a new radial arm shown in our illustration (Fig. 1) at A, to which is cast a curve, B. This curve has been carefully drawn to meet the requirements of the winding process in all its stages, and when once adjusted it is perfect in its action through them all. It will be obvious from its structure that it will meet the necessities of the case more perfectly than the quadrant. The radial arm is actuated by a wheel upon a short shaft attached to the carriage working into a fixed rack connected to the inside of the headstock frame in a position corresponding to that of the rack, C, shown in the illustration. The short shaft just mentioned carries a second wheel which works into the rack, C, which is loose, and has a traverse of 21 in., one-third the distance traversed by the mule carriage. On a projection from its extremity it carries the bowl, D, which, working in contact with the face of the curve, governs the winding throughout, and gives a better movement than the quadrant, the result being, when once properly adjusted, unalterable and perfect winding. Another improvement is a new and very neat method of putting the winding click into and out of gear, in which arrangement the cone is dispensed with. Our second illustration (Fig. 2) gives a view of the opposite side of the headstock, and shows how far its details have been affected by these improvements.

All practical men have long known the importance of possessing a good "nosing" apparatus, in order to make satisfactory yarn, and avoid excessive waste in the winding and weaving processes of the manufacturing division of the trade. This difficulty is caused by the fact that the mule spindle is not a cylinder, but commencing with a given diameter tapers to its apex, where the diameter is only about one-third that of the spindle at the point upon which the building of the cop commences. Had the spindle been of uniform thickness, Roberts' invention would have met all requirements without the necessity for any subordinate "nosing" arrangement. When, however, in spinning, the cop had been built some distance up the spindle, it was found that the revolution of the spindle with its diminished diameter failed to take up the yarn before the carriage got home. This made snarled yarn and slack "noses" to the cops, which subsequently became "ruffled" or "halched," these faults causing a heavy percentage of waste. The attempt to remedy this evil led to the invention of "nosing" appliances, the object sought being to discover a means of winding the yarn tightly upon the spindle at all its varying diameters.

FIG. 1.—IMPROVED ONE THOUSAND SPINDLE MULE.

Numerous plans have been tried, but with the exception of one or two they have only been very qualified successes. Their chief defects have been that they have only imperfectly remedied the evil, or have exceeded it somewhat by coming into operation too soon and injuring the yarn either by breaking it or drawing it into weak places at the nip of the rollers. The happy mean was difficult to attain. Mr. Macqueen, the manager for Messrs. Walker & Hacking, and the inventor of the improvements under our notice, has devoted a good deal of thought to this important matter. He found that the proper point at which the apparatus should come into operation was when the carriage was at a distance of 5 in. from home, or the termination of its inward run. He has therefore devised an improved "nosing motion," which consists of a grooved pulley attached to the wheel of the winding-on barrel. On the barrel shaft is placed a lever which carries a V piece which takes into the groove of the pulley. On the same shaft is a segment of a wheel from which a lug projects, and a small rod connects it with the V piece. A second segment wheel is carried on a stud fixed in the framing, and gears into the first segment. Upon the second segment a tail piece is cast. On the floor is placed an incline with which the tail piece comes into contact, and through the parts described operates the winding-on barrel, through which the spindles receive the proportionate acceleration required in winding to compensate for the diminution of their winding surfaces. The incline is worked forward from the cop builder, which gives the necessary increase of winding for every stretch. It will be obvious to the reader that the essential parts of this apparatus can be brought into operation at any distance from the roller beam.

Mr. Macqueen has also introduced a new cam shaft, embodying several improvements. On the cam shaft at the back is placed a loose wheel, which gears into the backing-off wheel and is driven by it. The last named wheel is always in motion—that is, when the mule is working. One side of it forms an internal cone into which fits an external cone, the latter being cast upon its own shaft. On the opposite end of this cone shaft is a double cam with an incline and stop placed in different planes. In front of this cam is a rod with a projection. A small L lever is fixed in the framing, and one end of this lever bears upon the back of the rod that carries the projection upon which the cam rests. To the other end of the lever is attached a rod carrying on its opposite extremity a fork which takes into the groove in the cam shaft. These roughly described constitute the parts, the operation of which is as follows: The rod with the projection has a double action; it is moved on end by the action of the carriage at either the head or the beam, which brings it into the one or the other plane of the double cam, when the small L lever through the action of a spring forces it forward toward the center of the shaft, and brings the internal cone on the cam shaft into contact with the external cone upon its shaft, and sets the latter in motion. When the shaft has made half a revolution, the incline upon the double cam presses back the projection upon the rod, withdraws the clutch, and stops the shaft. The necessary changes are thus made with rapidity, certainty, and assurance.

In addition to the above there are many improvements in details, the aggregate of which go to make this mule one of the most perfect before the notice of the trade. The headstock, slips, and builder are all laid on one strong foundation plate. The headstock is very substantial in all its details; new wheel gearing has been cut for all the parts with a new and improved form of teeth, which combine strength with almost noiseless running. The carriage square is more than ordinarily neat and substantial, and gives great steadiness to the movement of the carriage. The builder has been increased in strength, having a deep copping rail well supported on four shaper plates with loose run-down incline, worked also by two shaper plates, while the connections from the builder are substantial and simple. The arrangement of the rim-band pulleys has been improved, so that the tightness of the band is no longer affected by the motion of the carriage. An improved faller motion has also been introduced, which brings the faller wire down toward the

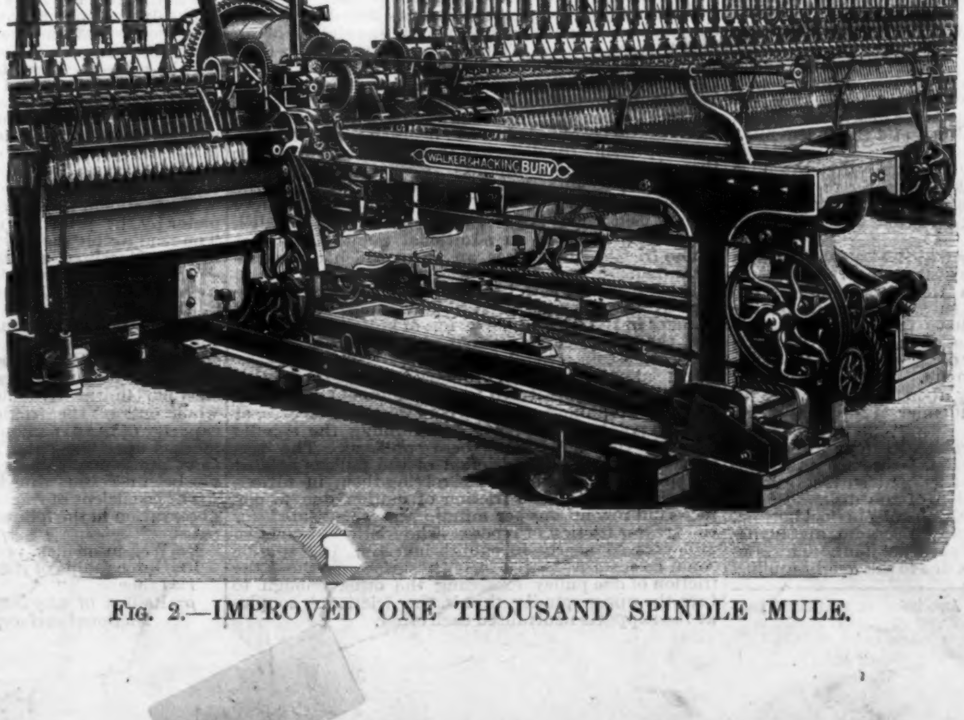


FIG. 2.—IMPROVED ONE THOUSAND SPINDLE MULE.

spindle point, in order to secure correct backing off. All the roller gearing is placed at the headstock ends of the roller beams. The change wheels are arranged in an improved manner, giving increased facilities for effecting the required changes, while the wheels themselves are of more convenient sizes than those commonly in use. The gain wheel contains 105 teeth, while the slubbing wheels have 50 and 25 respectively. The former enables the operator to make a very fine change. The rimband and carrier pulleys are of large size, which greatly diminishes friction and wear and tear of the bands. The in-taking and out-taking motions cannot by any chance be in gear and acting in opposition at the same time. The in-taking motion is withdrawn by the carriage in the event of the cam not withdrawing it. By a novel and simple arrangement of the gearing for the backing the cam off and the scroll shafts, no carrier pulleys are required for tightening the band from the countershaft that drives these motions. The connections from the front to the back are very simple in their construction and neat in their arrangement.

As we have observed previously, the mule, which we and hundreds of practical men have inspected during the past few weeks, contains 1,000 spindles, not being a small sample machine, but one that will form part of the plant of a large mill in the outskirts of Manchester. The spindles are 1⅝ in. gauge, 17¾ in. long, and 8½ in. out of the bolster. The mule was running 5 stretches of 64 in. in 64 seconds, with an 18 in. rim pulley and 12 in. pulley on tin roller, the tin roller being 6 in. diameter with a ⅝ in. wharve on the spindle. The creel is made in two heights, and the rollers double bossed, single roving. The latter, however, are points of detail that can be varied to suit the taste or notions of purchasers.—*Textile Manufacturer.*

LUBRICATING OILS.

MEASUREMENTS OF FRICTION OF LUBRICATING OILS.*

By C. J. H. WOODBURY, Boston, Mass.

AT the meeting of this society held in November, 1880, the writer presented a paper under the same title, giving the comparative results of some measurements of friction upon a variety of lubricating oils, submitted to a somewhat narrow range of conditions. On this occasion it is proposed to treat the subject from a different, but perhaps equally practical, point of view, and limit the subject to the examination of a single lubricant under a wide range of investigation.

In the course of some work on this subject for the Factory Mutual Insurance Companies, it became a matter of importance to know the coefficient of friction of a lubricant at a series of temperatures and pressures. These measurements were made upon another machine designed by the writer, similar in principle, but differing from the one used in the previous experiments in its general construction. The earlier machine was made for the specific purpose of testing spindle oils, and fulfilled conditions of high speeds and light pressures in a satisfactory manner, but was unsuited for work with heavy pressures upon the standard bearing where the friction was measured.

A standard brand of mineral oil, free from admixture of any animal oil, was selected for these experiments, because previous experience had shown that it was more uniform than any other lubricating oil, and duplicate samples could be obtained when desired. A test of this oil showed:

Flash	342 deg. Fahr.
Fire	410 "
Evaporation by exposure to 140 deg. Fahr. for twelve hours	0·02
Specific gravity	0·888

The operation of the machine is based upon the principle of measuring the friction between two annular disks, and the whole designed for the purpose of observing this with precision.

The machine, shown in perspective in Fig. 1 and in elevations in Figs. 2 and 3, consists of a cast iron frame in the form of an arch, with a brace at the rear, and further stiffened with transverse webs arranged to present the utmost rigidity against the stresses liable to be applied to the machine.

The lower disk is secured upon the top of an upright shaft, its top being an annulus, ground to a true plane surface. Upon this rests the upper disk, which is in the form of a hollow ring based upon a flat plate, and is made of very hard composition, cast in one piece. The bottom of this disk is scraped to a true plane surface, so that the contact between these two disks is uniform.

A partition divides the interior of the hollow ring forming the upper disk, so that water can be introduced through the connecting tubes to control the temperature of the disks, and in some instances it is desired to use the water as a medium to retain the heat of friction. The sides and top of the other disk are surrounded by a case made of hard rubber, and the space filled with eider down.

In experimenting, ice water is generally used to reduce the temperature of the disks to nearly the freezing point of water, and then the friction is noted at each degree of the rise in temperature due to the heat of friction.

A tube of thin copper, closed at the bottom, reaches through to the bottom of the disk, and a thermometer with the bulb placed within this tube indicates the temperature of the frictional surface. A tube leading through the upper disk conducts the lubricant under trial to the recess in the middle of the lower disk. The upper end of this tube, being of glass, indicates the supply and rate of feeding of the oil. As the friction of a journal depends quite largely upon the method of lubrication, uniformity in the manner of supply is of the utmost importance.

Over the upper disk, a yoke with four arms rests upon four columns which extend through the upper disk to the middle of the frictional surfaces; these columns being cast as a portion of the disk. In the center of this yoke is a hole with hemispherical bottom. The lower end of the upper spindle is round, and fitting into this hole makes a ball and socket joint. This construction transmits the stress due to the weight applied

* Paper read before the American Association of Mechanical Engineers.—*Engineering.*

TABLE I.—RESISTANCE OF FRICTION OF A PARAFFIN OIL AT A VELOCITY OF 300 FT. PER MINUTE.

Pressure in Pounds per Square Inch.	Temperatures.												
	deg. 40	deg. 45	deg. 50	deg. 55	deg. 60	deg. 65	deg. 70	deg. 75	deg. 80	deg. 85	deg. 90	deg. 95	deg. 100
	Resistance of Friction.												
1	2.69	2.39	2.13	1.91	1.70	1.51	1.34	1.19	1.06	.95	.85	.75	.69
2	2.99	2.61	2.32	2.06	1.86	1.66	1.50	1.34	1.21	1.09	.99	.89	.80
3	3.16	2.78	2.49	2.23	2.00	1.80	1.63	1.47	1.32	1.20	1.10	.99	.90
4	3.34	2.93	2.62	2.35	2.12	1.92	1.74	1.59	1.45	1.33	1.21	1.10	.99
5	3.50	3.08	2.76	2.49	2.25	2.04	1.85	1.69	1.55	1.43	1.30	1.19	1.09
6	3.65	3.20	2.88	2.61	2.36	2.15	1.96	1.79	1.65	1.51	1.39	1.28	1.17
7	3.79	3.32	3.00	2.71	2.47	2.25	2.06	1.89	1.74	1.61	1.48	1.36	1.26
8	3.91	3.43	3.10	2.82	2.57	2.34	2.16	1.99	1.83	1.69	1.56	1.45	1.34
9	4.05	3.56	3.22	2.93	2.67	2.45	2.25	2.07	1.92	1.78	1.65	1.53	1.42
10	4.18	3.66	3.33	3.03	2.77	2.54	2.34	2.17	2.01	1.86	1.74	1.62	1.51
11	4.30	3.79	3.43	3.14	2.88	2.65	2.45	2.28	2.11	1.96	1.83	1.70	1.59
12	4.41	3.89	3.55	3.25	2.99	2.75	2.54	2.36	2.19	2.04	1.91	1.78	1.66
13	4.52	4.00	3.65	3.35	3.08	2.84	2.63	2.44	2.27	2.13	1.99	1.85	1.73
14	4.64	4.10	3.75	3.44	3.16	2.93	2.72	2.53	2.36	2.22	2.07	1.94	1.81
15	4.75	4.21	3.85	3.55	3.26	3.02	2.80	2.61	2.44	2.29	2.15	2.01	1.88
16	4.85	4.32	3.95	3.64	3.36	3.12	2.90	2.70	2.53	2.38	2.23	2.09	1.95
17	4.95	4.42	4.06	3.75	3.46	3.21	3.00	2.79	2.62	2.46	2.31	2.17	2.04
18	5.08	4.54	4.16	3.84	3.56	3.30	3.08	2.89	2.71	2.54	2.40	2.25	2.12
19	5.18	4.63	4.26	3.93	3.65	3.40	3.18	2.98	2.80	2.64	2.49	2.33	2.21
20	5.28	4.73	4.35	4.03	3.75	3.49	3.27	3.07	2.89	2.73	2.57	2.41	2.27
21	5.36	4.84	4.46	4.13	3.83	3.59	3.36	3.16	2.98	2.82	2.65	2.49	2.35
22	5.46	4.94	4.56	4.23	3.94	3.68	3.45	3.25	3.07	2.90	2.73	2.57	2.42
23	5.55	5.05	4.65	4.32	4.03	3.76	3.54	3.33	3.15	2.97	2.81	2.64	2.49
24	5.65	5.13	4.74	4.41	4.10	3.84	3.62	3.42	3.23	3.05	2.89	2.72	2.56
25	5.75	5.22	4.83	4.50	4.19	3.93	3.70	3.49	3.31	3.13	2.95	2.79	2.63
26	5.83	5.31	4.92	4.58	4.29	4.01	3.78	3.57	3.38	3.21	3.03	2.86	2.71
27	5.93	5.41	5.01	4.67	4.35	4.09	3.86	3.65	3.46	3.29	3.11	2.94	2.78
28	6.03	5.50	5.10	4.75	4.45	4.18	3.95	3.73	3.54	3.36	3.18	3.02	2.85
29	6.10	5.59	5.19	4.84	4.54	4.26	4.02	3.81	3.62	3.44	3.26	3.09	2.92
30	6.19	5.67	5.28	4.93	4.61	4.33	4.10	3.88	3.69	3.51	3.34	3.15	2.99
31	6.28	5.75	5.36	5.01	4.69	4.41	4.16	3.95	3.76	3.58	3.40	3.23	3.05
32	6.35	5.83	5.43	5.09	4.77	4.49	4.24	4.04	3.84	3.65	3.46	3.29	3.12
33	6.43	5.91	5.52	5.16	4.85	4.57	4.33	4.12	3.91	3.72	3.54	3.35	3.18
34	6.50	6.00	5.60	5.25	4.94	4.65	4.41	4.19	3.98	3.80	3.61	3.43	3.24
35	6.58	6.08	5.69	5.32	5.01	4.73	4.48	4.26	4.05	3.86	3.68	3.50	3.32
36	6.65	6.15	5.75	5.40	5.09	4.81	4.57	4.34	4.13	3.93	3.75	3.56	3.38
37	6.73	6.22	5.83	5.49	5.17	4.88	4.64	4.41	4.21	4.01	3.82	3.63	3.45
38	6.80	6.31	5.92	5.57	5.25	4.97	4.72	4.49	4.29	4.09	3.89	3.70	3.52
39	6.89	6.39	6.00	5.65	5.34	5.04	4.79	4.56	4.35	4.15	3.95	3.76	3.57
40	6.97	6.46	6.06	5.73	5.41	5.12	4.86	4.63	4.42	4.21	4.02	3.82	2.62

TABLE II.—COEFFICIENT OF FRICTION OF A PARAFFIN OIL AT A VELOCITY OF 300 FT. PER MINUTE.

Pressure in Pounds per Square Inch.	Temperatures.												
	deg. 40	deg. 45	deg. 50	deg. 55	deg 60	deg. 65	deg. 70	deg. 75	deg. 80	deg. 85	deg. 90	deg. 95	deg. 100
	Coefficients												
1	.5380	.4780	.4260	.3820	.3400	.3020	.2680	.2380	.2120	.1900	.1700	.1500	.1380
2	.2990	.2610	.2320	.2060	.1860	.1660	.1500	.1340	.1210	.1090	.0990	.0890	.0800
3	.2107	.1853	.1660	.1487	.1333	.1200	.1080	.0980	.0880	.0800	.0733	.0675	.0600
4	.1670	.1465	.1310	.1175	.1060	.0960	.0870	.0795	.0725	.0665	.0605	.0550	.0495
5	.1400	.1232	.1104	.0996	.0900	.0816	.0740	.0676	.0620	.0572	.0520	.0476	.0436
6	.1217	.1067	.0960	.0870	.0787	.0717	.0653	.0597	.0550	.0503	.0463	.0427	.0390
7	.1083	.0949	.0847	.0774	.0706	.0643	.0588	.0540	.0497	.0460	.0423	.0388	.0360
8	.0978	.0858	.0775	.0705	.0642	.0585	.0540	.0498	.0458	.0423	.0390	.0359	.0335
9	.0900	.0791	.0715	.0651	.0593	.0544	.0500	.0460	.0427	.0395	.0367	.0340	.0316
10	.0836	.0732	.0666	.0606	.0554	.0508	.0468	.0434	.0402	.0372	.0348	.0324	.0302
11	.0782	.0687	.0624	.0571	.0524	.0482	.0445	.0411	.0384	.0356	.0330	.0311	.0289
12	.0735	.0648	.0592	.0542	.0498	.0458	.0423	.0393	.0365	.0340	.0315	.0297	.0277
13	.0695	.0615	.0561	.0515	.0474	.0437	.0405	.0375	.0349	.0328	.0306	.0285	.0266
14	.0663	.0586	.0533	.0491	.0451	.0419	.0389	.0361	.0337	.0317	.0296	.0283	.0259
15	.0633	.0561	.0513	.0475	.0436	.0403	.0375	.0349	.0325	.0305	.0286	.0268	.0257
16	.0606	.0540	.0494	.0455	.0420	.0390	.0363	.0338	.0316	.0298	.0278	.0261	.0244
17	.0582	.0520	.0477	.0441	.0407	.0378	.0353	.0328	.0308	.0289	.0272	.0255	.0240
18	.0564	.0504	.0462	.0426	.0396	.0364	.0342	.0321	.0301	.0282	.0264	.0250	.0235
19	.0545	.0487	.0448	.0414	.0384	.0358	.0335	.0314	.0295	.0278	.0262	.0245	.0233
20	.0528	.0473	.0435	.0403	.0375	.0349	.0327	.0307	.0289	.0273	.0257	.0241	.0227
21	.0510	.0460	.0424	.0394	.0364	.0342	.0320	.0302	.0284	.0268	.0252	.0238	.0224
22	.0496	.0450	.0414	.0384	.0358	.0334	.0314	.0296	.0280	.0264	.0248	.0234	.0220
23	.0483	.0439	.0404	.0374	.0350	.0327	.0308	.0290	.0274	.0258	.0244	.0230	.0216
24	.0471	.0436	.0395	.0368	.0342	.0320	.0302	.0285	.0269	.0254	.0241	.0228	.0213
25	.0460	.0418	.0386	.0360	.0336	.0314	.0296	.0279	.0265	.0250	.0236	.0223	.0210
26	.0448	.0408	.0378	.0352	.0328	.0308	.0290	.0274	.0260	.0246	.0233	.0221	.0208
27	.0439	.0400	.0370	.0346	.0322	.0302	.0286	.0270	.0256	.0243	.0230	.0218	.0206
28	.0430	.0392	.0364	.0340	.0318	.0298	.0282	.0266	.0252	.0240	.0228	.0216	.0204
29	.0421	.0386	.0358	.0334	.0313	.0294	.0277	.0263	.0250	.0237	.0225	.0213	.0201
30	.0413	.0378	.0352	.0328	.0307	.0289	.0273	.0259	.0246	.0234	.0222	.0210	.0199
31	.0404	.0371	.0347	.0323	.0304	.0284	.0268	.0255	.0243	.0231	.0219	.0208	.0197
32	.0397	.0364	.0339	.0318	.0298	.0281	.0265	.0252	.0240	.0228	.0216	.0205	.0195
33	.0390	.0358	.0335	.0313	.0294	.0277	.0262	.0249	.0237	.0226	.0214	.0203	.0193
34	.0382	.0353	.0330	.0309	.0290	.0274	.0260	.0246	.0235	.0224	.0213	.0202	.0191
35	.0376	.0347	.0325	.0304	.0286	.0270	.0256	.0243	.0231	.0220	.0210	.0200	.0190
36	.0370	.0342	.0320	.0300	.0283	.0267	.0254	.0244	.0230	.0219	.0208	.0198	.0189
37	.0364	.0336	.0315	.0297	.0279	.0264	.0251	.0239	.0228	.0217	.0206	.0196	.0186
38	.0358	.0332	.0312	.0293	.0276	.0262	.0248	.0235	.0226	.0215	.0205	.0195	.0185
39	.0353	.0328	.0308	.0290	.0274	.0258	.0246	.0234	.0223	.0213	.0203	.0193	.0183
40	.0349	.0323	.0303	.0286	.0271	.0256	.0243	.0232	.0221	.0211	.0201	.0191	.0181

upon the spindle to four points in the middle line of the frictional surfaces, and the strains due to excessive loads will not distort the disks so as to interfere with the uniformity of the thickness of the film of oil between the surfaces; while the ball and socket joint allows the surfaces to meet without any cramp or binding due to imperfection or wear, which would prevent the surfaces from revolving in a true plane.

The axes of the upper and lower spindle do not coincide, but are on parallel lines about one-eighth of an inch from each other. This prevents the surfaces from wearing in rings, because the same points are not continuously brought in contact with each other.

A slight countersink in the top of the upper spindle receives the center point in the middle of a beam, which sustains the weighted platform beneath the table. The weight pressing the disks together is thus exerted along the axis of the upper spindle.

It has been found that it is essential to obtain the pressure by the direct application of weight, for any plan of using weighted levers or springs upon a disk requires the use of an additional point of support whose friction introduces an error which cannot be measured.

The upper disk with its load must be free to turn slightly in the easiest possible manner with slight changes in the friction. The use of knife edges to support the upper spindle was out of question, because it must be sustained in all directions.

Instead of holding it in ordinary journals, the friction of motion was substituted for the friction of repose, by placing two pulleys, whose arbors were long sleeves, at the two points of support, and running the spindle through the middle of these pulleys. The torsional effect due to the friction of the pulleys against the spindle was nullified by revolving them in reverse directions, so that the friction of motion due to one thousand revolutions per minute was substituted for the greater friction of repose. The frictio... the two pulleys is so nearly in equilibrium tha... spindle could be sustained on a smooth surfac... thout the friction of one pulley exceeding the othe... enough to turn the upper spindle; that is, the frictional couples at the supports neutralized each other.

At the left of the machine, a counter records the number of revolutions made during any given time. A lever at the top controls a small friction clutch, in order to stop or start the counter at any time during an experiment.

Under certain conditions, the friction varies so rapidly that the dynamometer measuring it must be instantaneous and automatic in its action.

The dynamometer shown on the right hand of the machine consists of a mechanism of segments and pinions for multiplying the deflection of a steel bar, and indicating the stress necessary to produce such deflection, by the position of the hand on the dial. An arm which ends in the arc of a circle projects from the lower surface of the upper disk, and is connected to the dynamometer with a flexible brass tape. When the machine is in operation, the lower disk is revolved, and tends to carry the upper disk around with it, by a force equal to the friction due to the lubricant between the disks.

The frictional resistance is obtained from the dynamometer by the principle of couples of equal moments. The reading on the dynamometer indicates the force of a couple whose arm is the length of the lever projecting from the upper disk, and this couple is opposed by a couple of equal moment, of which the dimensions of the frictional surface form the data for computing the arm, and the frictional resistance of the lubricant is the unknown quantity.

When the friction is too great for the dynamometer, a pair of compound levers reduces the stress upon the steel bar in the dynamometer to one-fifth that of the whole pull of the frictional component, so that the capacity of the dynamometer is five times the amount marked upon the dial. The resistances at higher pressures are so much less than was anticipated that it has not been necessary thus far to use these reducing levers.

The coefficient of friction it deduced from the data of observation in the following manner:

Let

P = Weight on disk, pounds.

R = Outer radius of frictional contact, feet.

r = Inner " " "

ρ = Radius of any infinitesimal ring or band of the frictional surface, feet.

N = Number of revolutions per minute.
W = Reading on dynamometer, pounds.
l = Length of arm on upper disk, feet.
φ = Coefficient of friction.

Suppose that the annular surfaces of the disk be divided into an infinite number of elementary areas by equidistant circles and radial lines, then will—

Width of band $= d\rho$ .... (1)

Angle between two successive radial lines $= d\theta$ .... (2)

Length of arc between two radii $= \rho\, d\theta$ .... (3)

Elementary area $= \rho\, d\rho\, d\theta$ .... (4)

Area of annulus $= \pi(R^2 - r^2)$ .... (5)

Pressure per unit of area $= \dfrac{P}{\pi(R^2 - r^2)}$ .... (6)

Pressure on elementary area $= \dfrac{P\,\rho\, d\rho\, d\theta}{\pi(R^2 - r^2)}$ .... (7)

Friction on elementary area $= \dfrac{\varphi P\,\rho\, d\rho\, d\theta}{\pi(R^2 - r^2)}$ .... (8)

Moment of friction on elementary area $= \dfrac{\varphi P\,\rho^2\, d\rho\, d\theta}{\pi(R^2 - r^2)}$ .... (9)

Moment of friction on entire disk $= \dfrac{\varphi P}{\pi(R^2 - r^2)} \displaystyle\int_r^R \int_0^{2\pi} \rho^2\, d\rho\, d\theta$ (10)

Integrating $= \dfrac{2\pi\varphi P}{\pi(R^2 - r^2)} \left\{\dfrac{\rho^3}{3}\right\}_r^R$ .... (11)

Substituting the limits $= \dfrac{2\varphi P(R^3 - r^3)}{3(R^2 - r^2)}$ .... (12)

Work of friction per minute $= \dfrac{4\varphi\pi P N(R^3 - r^3)}{2(R^2 - r^2)}$ .... (13)

Resistance of the dynamometer $= 2\pi l W N$ .... (14)

The friction equals the resistance, hence

$$\frac{4\varphi\pi P N(R^3 - r^3)}{2(R^2 - r^2)} = 2\pi l W N \quad (15)$$

$$\varphi = \frac{3 W l (R^2 - r^2)}{(2\pi(R^3 - r^3)} \quad (16)$$

This is not in a form convenient for continual use, and is susceptible of much simplification, if the proper dimensions are used for the various parts in connection with the frictional surfaces and the dynamometer arm. It is also important for the sake of simplicity that the length of the line of mean area of the disk be 1 ft., so that the number of revolutions per minute is equivalent to the frictional velocity in feet per minute. For convenience, it was desirable that the area of the disks be 10 square inches.

If c = radius of circle whose circumference is 12 in., then—

$$2\pi c = 12 \quad (17)$$

$$c = \frac{12}{2\pi} = 1{\cdot}909 \text{ in.} \quad (18)$$

Area within this circumference,

$$\pi c^2 = 11{\cdot}46 \text{ square inches} \quad (19)$$

If this circumference divide the annulus of 10 square inches area into two equal parts, then the outer rim of the annulus will circumscribe an area of 11·46 + 5 = 16·46 square inches. The radii corresponding to these circles are:

$$R = \sqrt{\frac{A}{\pi}} = 2{\cdot}289 \text{ in.} = 0{\cdot}1907 \text{ ft} \quad (20)$$

$$r = \sqrt{\frac{a}{\pi}} = 1{\cdot}434 \text{ in.} = 0{\cdot}1195 \text{ ft} \quad (21)$$

$$R^2 - r^2 = 0{\cdot}0221 \text{ ft.};\ R^3 - r^3 = 0{\cdot}00523 \text{ ft.} \quad (22)$$

Substituting the values in equation (16)

$$\varphi = \frac{6{\cdot}338\, W l}{P} \quad (23)$$

This equation can be made still more simple if the length of the arm l is of such length that

$$\varphi = \frac{2W}{P} \quad (24)$$

Substituting this value of φ in equation 23, we have

$$l = 0{\cdot}3156 \text{ ft.} = 0{\cdot}3787 \text{ in.}$$

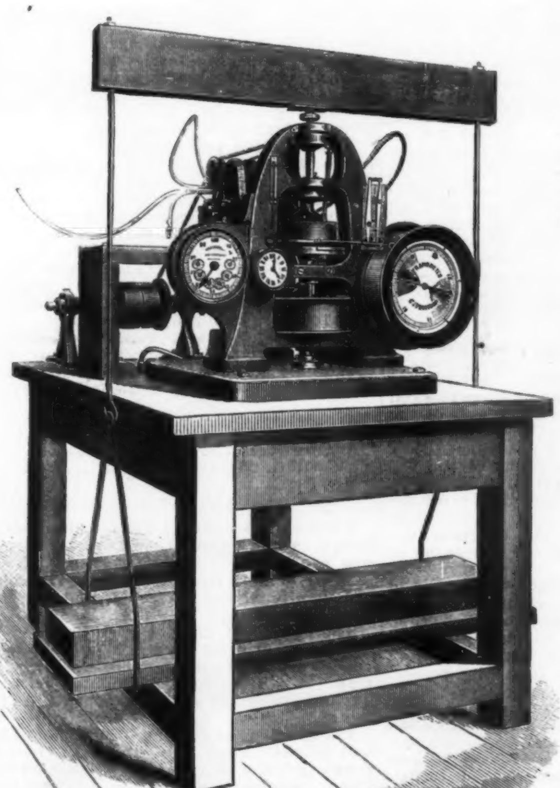
Generally the weight on the disks is referred to in pounds to the square inch, then

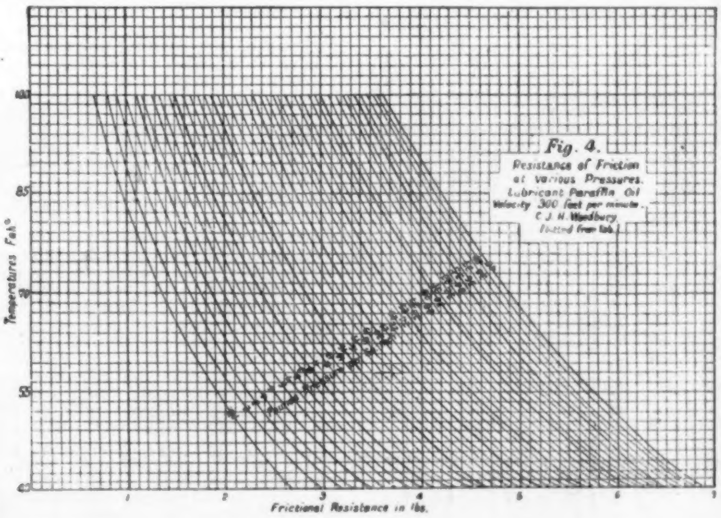
$$\varphi = \frac{W}{5p} \quad (25)$$

If the reducing levers which have been referred to are used, the reading on the dynamometer is one-fifth of the pull on the arm, and when the machine is used with this attachment

$$\varphi = \frac{W}{p} \quad (26)$$

The blank used in taking notes of the observations





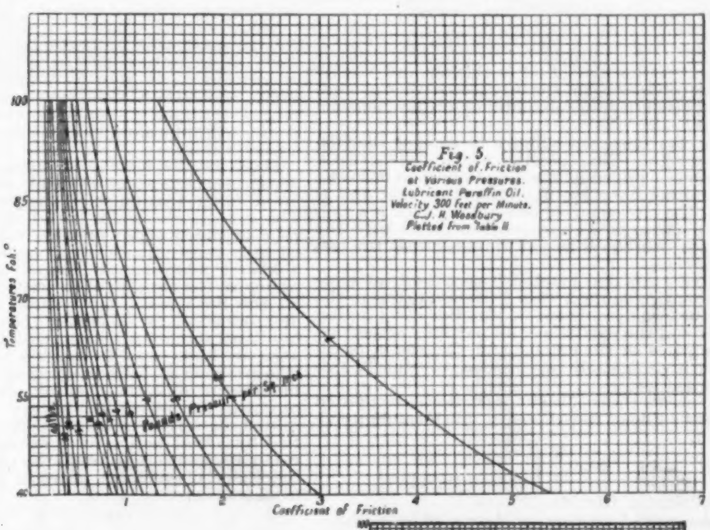


Fig 2

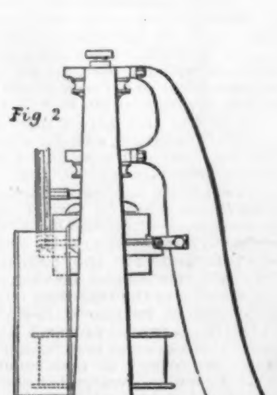
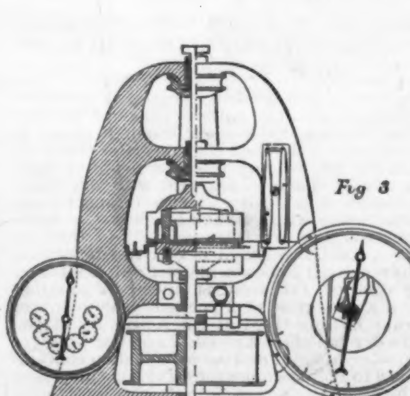
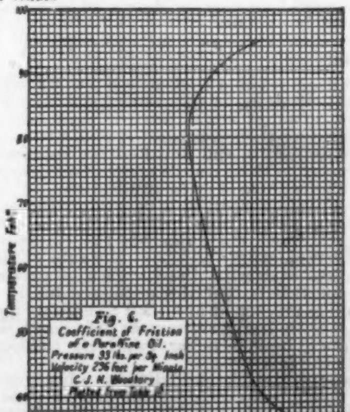


Fig 3





THE MEASUREMENT OF FRICTION OF LUBRICATING OILS.

made upon the work with the machine is shown in Table III.

After the temperature of the disks has been reduced by a current of ice water, the circulation of the water is stopped, the machine started, and the reading of the dynamometer noted at each degree of temperature.

As the machine is generally used without the compound levers, the column of coefficient of friction is obtained by dividing the dynamometer reading by five times the pressure in pounds per square inch.

Table I. contains the record of the dynamometer readings, and shows the resistance of friction of a paraffin oil tested in the machine, at a series of pressures of 1 lb. to 40 lb. per square inch, and temperatures from 40 deg. to 100 deg. Fahr. Readings were noted at each degree, but a tabulation of the friction at every fifth degree answers all required purposes.

The results are clearer expressed by the diagram, which shows in a graphical manner the relations of these measurements to each other within the limits of the data (Fig. 4).

As the temperature rises, the increasing fluidity of the oil diminishes the friction within the limits of free lubrication.

It is also seen that the resistance does not increase proportionately with the pressure, nor at a uniform rate. The lubricant, while separating the surfaces of a journal, and protecting them from injury, also introduces the resistance of its own cohesion; and at

TABLE III.—*Boston Manufacturers' Mutual Fire Insurance Company, March* 12, 1883.

Frictional Tests of No. 58 Unknown Mineral Oil.

Temp. Disc.	Ending 95	Duration of experiment	..	21
" "	Beginning .. 35	Counter ..	Ending ..	910,382
Temp. Room	Ending 60		Beginning	904,162
	Beginning .. 62	Total revolutions		6220
Time	Ending 10.31	Rev. per minute	.. ..	296
	Beginning ..10.10	Feet " "		

Pressure on Frictional Surfaces 33 lb. per Square Inch.

Temperature.	Dynamometer.	Coefficient of Friction.	Temperature.	Dynamometer.	Coefficient of Friction.	Temperature.	Dynamometer.	Coefficient of Friction.
35	8.00	.0485	64	4.80		93	5.45	
36	7.00		65	4.75	.0258	94	5.80	
37	6.65		66	4.70		95	6.10	.0370
38	6.45		67	4.66				
39	6.30		68	4.60				
40	6.12	.0371	69	4.57				
41	6.02		70	4.54	.0275			
42	5.90		71	4.50				
43	5.82		72	4.45				
44	5.75		73	4.42				
45	5.68	.0344	74	4.39				
46	5.61		75	4.37	.0265			
47	5.55		76	4.36				
48	5.49		77	4.35				
49	5.42		78	4.32				
50	5.36	.0325	79	4.30				
51	5.32		80	4.29	.0260			
52	5.28		81	4.27				
53	5.22		82	4.25				
54	5.17		83	4.25				
55	5.12	.0310	84	4.28				
56	5.09		85	4.31	.0261			
57	5.06		86	4.41				
58	5.03		87	4.51				
59	4.99		88	4.62				
60	4.95	.0300	89	4.75				
61	4.91		90	4.90	.0297			
62	4.88		91	5.05				
63	4.84		92	5.22				

small pressures the film of oil is thicker and the resistance due to viscosity of the oil exceeds that at high pressures, when a smaller amount of oil lies between the surfaces.

A film of the lubricant adheres to each of the frictional surfaces, and that portion which lies between these two films is pulled in one direction upon one side, and in the other direction upon the other side, and as a resultant, the movement of this center layer is a rolling motion, whose rate of progression varies with the difference between the adhesion of oil between the two frictional surfaces.

Nearly five years ago I stated,* as a result of some early work on this subject, that "friction exists at the surface of the two disks between the film of oil acting as a washer and the particles of oil partially embedded within the pores of the metal," and the result of all subsequent investigation has tended to confirm this view of the subject.

Table II. shows the coefficient of friction as computed from the first table of resistances by the formula previously given.

$$\varphi = \frac{W}{5p}$$

φ = coefficient of friction.
W = resistance of friction as shown as by dynamometer, in pounds.
p = pressure upon frictional surfaces in pounds per square inch.

It does not deem feasible to deduce a formula which will meet the limitations of this table; and if such an equation were given, it could serve no practical use either in practice or theory, because it would be bound to these specific results, and unsuited for application elsewhere; but from these results one can observe certain generalities capable of wide application.

It will be observed that, in a general way, the coefficient of friction diminishes inversely with the pressure, and directly with the fluidity of the oil, as indicated by the temperature; and that the rate of these differences diminishes with the increase of pressure. The reason for this is that the resistance due to the viscosity of oil is greater at low than at high temperature, and that with heavier pressures the film of oil is actually thinner, besides being relatively smaller in proportion to the pressure.

On this account, the frictional difference between lubricants is much less at high than at low pressure during continuous lubrication, although the differences in regard to endurance are more widely marked at high pressure.

It is almost universally asserted to be a general principle that the coefficient of friction is independent of the pressure, regardless alike of the actual facts in the matter and of the limitations of Morin's experiments,* which form the common source of authority on the subject.

The coefficient of friction between any two solids is accepted to be a constant ratio; but when a lubricating medium is interposed, then the frictional relation between these three substances becomes variable, according to the effect of temperature, pressure, and velocity upon the lubricant, and the problem bears certain analogies to those of hydrodynamics relative to the efflux of a fluid through a narrow orifice. When the pressures are great, these variables form such a small ratio to the whole frictional resistance that they escape observation unless the measurements of friction are taken in an accurate manner.

If the lubricant is not used, the variables disappear altogether, and then the coefficient of friction becomes reduced to a constant ratio. This latter class of friction is rarely considered, except for the friction of repose, in matters pertaining to the stability of structures; while the problems of mediate friction enter into the operation of the moving parts of every machine.

This is not the place to enter into a criticism of the work of Morin, but it should be observed that his investigations were devoted to measurements of a sled upon tracts in the interests of the Ordnance Corps; and although he made some experiments upon friction of oiled bearings, they were not subjected to the frictional conditions of lubricated journals under conditions analogous to those in machines.

In a letter† written March 15, 1879, Gen. A. Morin said [translation]: "The results furnished by my experiments as to the relations between pressure, surface, and speed, on the one hand, and sliding friction on the other, have always been regarded by myself, not as mathematical laws, but as close approximations to the truth within the limits of the data of the experiments themselves."

Considerations of safety have fixed the minimum limit of the flashing point of a lubricating oil at 300 deg. Fahr., with a proportion of volatile matter not exceeding five per cent. thrown off by exposure to 140 deg. Fah. for twelve consecutive hours. With the saving clause of proper limits of pressure, a fluid oil offers less frictional resistance than a viscous one.

Although the data in Table II. show that the coefficient of friction diminishes with the increase of fluidity, it does not warrant any extreme position in respect to the use of thin oils, except for light pressures, because, under all circumstances, the film of oil must be thick enough to keep the surfaces of a journal from actual metallic contact. In the severe work of heavy pressure a viscous oil must be used in order to retain its place upon the bearing surfaces in sufficient thickness to protect the inequalities upon the journal from colliding. In some places, it has been found that the use of an extremely thin oil resulted in a diminution of the friction of the machines at the expense of more rapid wear of the journals. Such results are not apt to occur upon journals of light pressure, such as spindles, where a thin oil is used with good judgment.

Table III. shows the record of a test of a very limpid mineral oil which reached, in the frictional machine, its limit of lubrication at 82 deg. Fahrenheit, under a pressure of 33 lb. to the square inch; beyond that point, the oil became so fluid that the pressure reduced the thickness of the sheet of oil, until portions of the surfaces met in actual contact.

At lower temperatures the greater resistance shows a large coefficient of friction on account of the viscosity of the oil, while the rise in friction at higher temperatures, as shown in the upper part of the curve, indicates a resistance produced by the collision of portions of the disks, and the diagram illustrates a graphical representation of the beginning of a hot bearing.

These results have been submitted in the hope of presenting facts which will add somewhat to the means for a fuller treatment of the problem of lubrication. The several economies pertaining to lubrication operate at the expense of each other. An economy of oil may represent an extravagance in motive power; a liberal allowance of limpid oil may save motive power at the expense of the repair account, and above all the final result must show the greatest amount of lubrication for a dollar. Lubricants are wasted, not worn out by attrition, and it is of more importance to know how to use oil than what oil to use. The problem of lubrication seeks to know what combination of oil casks, coal pile, and wear and tear will represent the fewest dollars; and in its broad sense it cannot be solved on any experimental basis, nor settled by a final dictum from any one source, but it will reach its solution through the practical experience of intelligent observation, aided by the resources of technical science.

* Transactions New England Cotton Manufacturers' Association, Fifteenth Annual Meeting, p. 61.

* Nouvelles Expériences sur le Frottement, Faites à Metzen, 1831. Par Arthur Morin, Capitaine d'Artillerie. 128 pp., 4to. Plates.
Second Mémoire. 1832. 103 pp., 4to. Plates.
Troisième Mémoire. 1833. 142 pp., 4to. Plates.

† Transactions Institution Mechanical Engineers of Great Britain, 1883, p. 666.

PHOTOGRAPHIC SURFACES MORE SENSITIVE FOR THE GREEN, YELLOW, AND RED RAYS.

By H. W. VOGEL.

IN this memoir, which is taken from the *Berichte der Deutsch. Chem. Gesell.*, the author speaks of the substances which, when added to silver bromide, render it sensitive to all rays. He finds that one and the same coloring matter acts in very different manners upon different surfaces. Paris violet used with dry silver bromide collodion is as sensitive for the orange rays as for the blue, while with gelatino-bromide the sensitiveness for the orange rays is scarcely 1-50 of that for the blue rays. Moist collodion is still less favorable. Eosine behaves in an opposite manner; if a solution containing 1-400 of this color is added to gelatino-bromide in the proportion of 2 per cent., the yellow of the spectrum has one-third of the sensibility of the blue. With dry collodion the yellow and the blue are equally sensitive to light, and moist collodion containing eosine is 8 to 10 times more sensitive for the yellow than for the blue.

COPYING MAPS AND PLANS.*

THERE are various methods by which maps, plans, tracings, etc., may be copied. There is that of producing black lines on a white ground, but I shall confine myself to two: First—The ferro-prussiate process, by which may be produced either white lines on a blue ground, or blue lines on a white ground. Second—The obtaining of copies with white lines on a blue ground. The face of the drawing is placed against the glass of the printing-frame, and the prepared paper is then placed on the drawing (the prepared side on the back of the drawing). It is advisable that the paper should be somewhat larger than the drawing, so as to leave a margin exposed to show the action of light upon it. The exposure required in very bright sunshine varies from five to fifteen minutes; but in the very dull days of winter it may require two or three hours, or even a whole day. During the exposure to light, the paper assumes various tints, from a greenish-blue to an olive tint. The print, when properly exposed, is taken from the printing-frame and immersed in clean water (which can be effected in any room) until the lines become purely white. The time required for washing occupies from five to ten minutes; but if warm water be used, the result is otained much more quickly. Overwashing reduces the intensity of the blue ground. I find, from experience, the copies darken considerably while drying. If the prints are very large, say four or five feet in length, and three feet wide or more, great care is required in taking them out of the washing water to prevent them from tearing. To prevent this I generally get an assistant to hold along wooden roller near, upon which the copy is placed. If a line or figure has been left out by mistake on the original drawing before being copied, the same can be produced upon the printed copy by using a solution of soda and water. To obtain blue lines on a white ground by this process, a negative must first be made, which is accomplished by placing in the printing-frame the drawing, with the back against the glass; then place over the drawing a piece of special ferro-prussiate paper (thin) prepared for the purpose, with the smooth surface against the face of the drawing, close the frame, and expose to the light. The process of the negative print is rather difficult to verify and check; therefore, in this process the use of a second frame as a test frame will be found very useful. The negative print should be exposed at least three or four times as long as that by which white lines on blue ground are produced. The negative print, after proper exposure, should be washed in clean water, and dried as before mentioned. If this be properly done, the print when finished should show a clear dark blue on being held up to the light.

The negative print is then placed in the printing-frame with the rough side against the glass, and thereon a piece of ferro-prussiate paper (the same as used for producing white lines on blue ground), with the prepared side against the negative—the exposure and operation to be the same as if producing white lines on blue ground. The copy thus treated will, when finished, have blue lines on white ground. I may also say the special negative paper can be used for producing white lines on blue ground by the following procedure as in the first instance.

Very pleasing pictures can be made by printing from negatives with this paper, which can be obtained ready prepared. If any one choose to prepare his own paper, he can do so by the use of the following formula:

	Parts.
Ammonia citrate of iron	1
Water	5
Ferricyanidine of potassiun	1
Water	4

Mix together in equal quantities.

I now come to the process for producing dark blue lines on a white ground. The advantages of this process are many. It can be worked in all weathers, and requires no dark room. Copies can be colored and varnished, altered and corrected, and last, but not least, they do not *fade*.

There are five distinct operations, viz.: 1st, exposure in the printing-frame; 2d, developing of copy in yellow prussiate solution; 3d, washing in first water tray; 4th, bleaching in acidulated bath; 5th, brushing and flushing in second water tray, and finally drying.

The glass in the printing-frame should be very clean and bright. Place the drawing to be copied in the printing-frame, and upon it a sheet of the sensitized paper, put the felt over all, and smooth outwards from the center with both hands, close the frame, and expose to the light. The time of exposure varies with the seasons of the year, state of the atmosphere, and quality and intensity of the light. In the sunlight in summer it only requires a few seconds, in the shade a few minutes, but in foggy and dull weather in winter half to three-quarters of a hour. The exposure can only be determined by constant practice and test slips. The test slips should be placed in the printing-frame alongside the tracing being copied. These small test slips are inserted so as to be about two-thirds inside and one-third outside the frame at the back. They can then be conveniently drawn out without opening or disturbing the print. The frame must be exposed to the direct action of the light, and no shadow allowed to fall on it. After a time, one of the test slips is drawn out and dipped in the prussiate solution, and its chemical action watched for from 40 to 50 seconds. Should the background remain perfectly yellow, and the lines come out blue, the exposure has been sufficient. During the testing the frame must be turned face downward, or otherwise screened from the light.

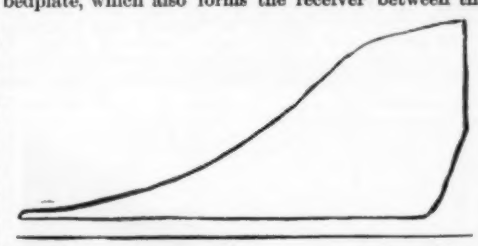
It is not necessary to develop the copies immediately after exposure, therefore all the printing might be done while the light is strongest, leaving the development until the evening or the following day. After exposure, the copy should be placed face downward on a board, and the edges turned up carefully, so as to form a sort of tray, three-quarter inch in depth. This renders the sheet more easy of manipulation, and leaves the back white when developed in the prussiate bath. The copy is now placed face downward, and floating on the prussiate bath for about thirty seconds. The operator should see that uniform contact takes place everywhere while in the solution; raise the copy,

* By Mr. T. Scotton. Abstract of a paper read before the Derby Photographic Society.

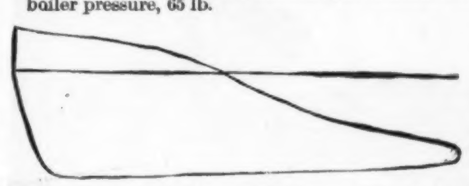
inclining it to allow the solution to drip off one corner, then particularly notice how the lines seem to stand out. If they stand out, and the ground remains perfectly yellow, the development may be considered complete. After development the copy is floated or immersed in the first water bath, in order to check the further action of the prussiate, and then immersed face upward in the acid bath, care being taken that the entire copy, both front and back, is saturated. In winter, the copies can be safely left immersed in the acid bath ten minutes or more; in hot weather three or four minutes may suffice. The surface of the copy should be worked all over carefully with a soft brush to start and loosen the blue mucilage. The copy is next placed face upward in the empty second water tray, and again well brushed to get rid of the superficial mucilage. Finally it is finished copiously with clean water, both front and back, so as to remove all traces of the previous chemical solution. For drying, lay the copies across semicircular rollers about three inches in diameter. Any blue stains on the copies may be removed, or alterations made, by the use of the blue solving supplied with the paper; any blue stains on the hands may be quickly removed by a very weak dilution of caustic potash. It is essential that the contents of the two chemical baths do not get mixed, or blue stains will appear. To prevent this, it is advisable to well rinse one's hands in clean water after each operation.

IMPROVED TANDEM ENGINES.

WE illustrate a 120 horse power horizontal tandem engine constructed by Messrs. Simpson & Co., of Pimlico, for the Gillingham Portland Cement Company, near Chatham, where it has been at work for the past two years driving machinery in connection with cement making. The cylinders are 14½ in. and 24 in. diameter with a stroke of 24 in.; both cylinders are bolted to one bedplate, which also forms the receiver between the



Diameter and stroke of high-pressure cylinder, 14½ in. by 24 in.; number of revolutions per minute, 110; boiler pressure, 65 lb.



Diameter and stroke of low-pressure cylinder, 24 in. by 24 in.; number of revolutions per minute, 110; vacuum gauge, 27 in.

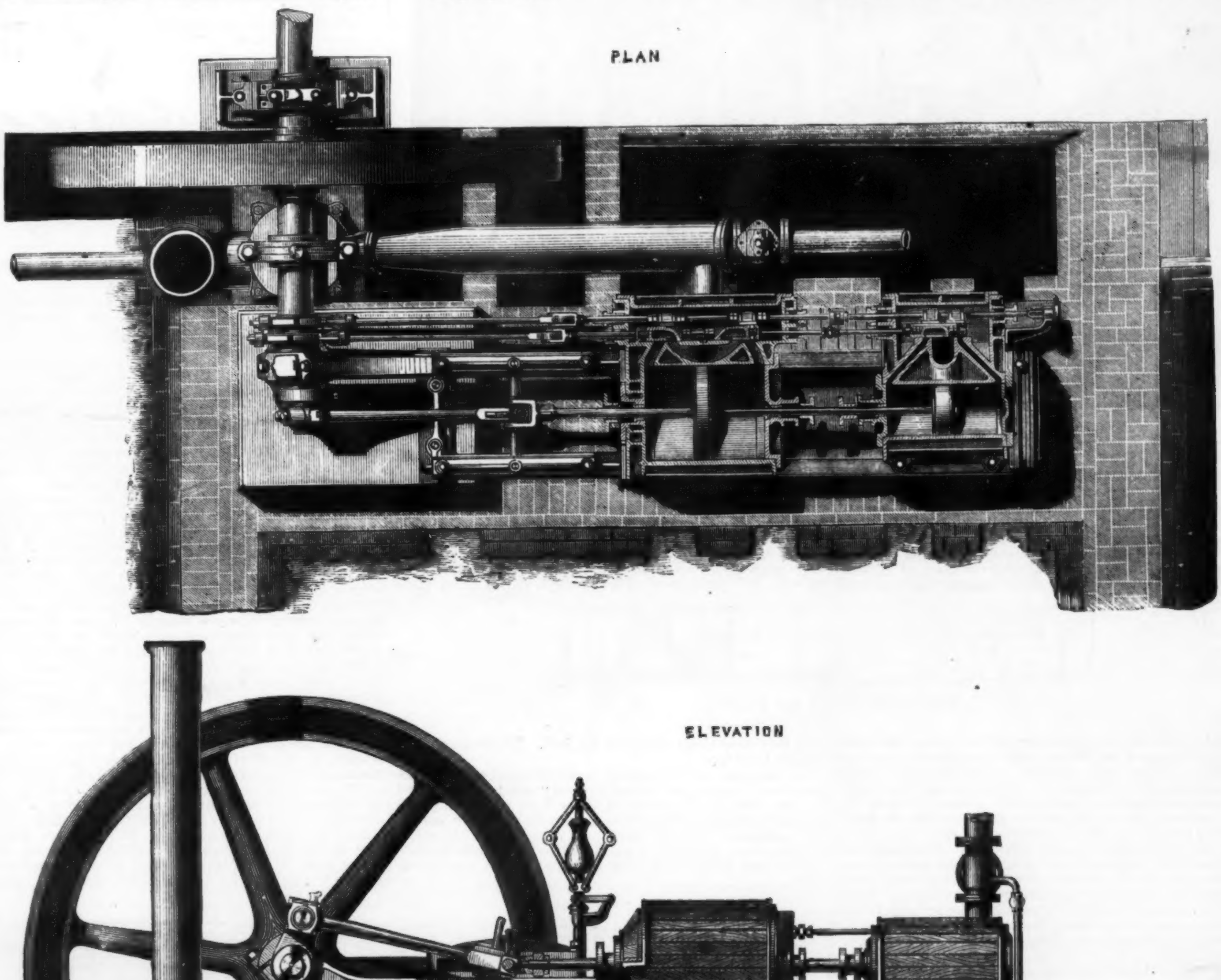
high and low pressure cylinders. The bed plate extends only to the front of the low pressure cylinder, the connection between that and the crank shaft bearing being formed by a frame in which the bearing is cast. The engine, which runs at 100 revolutions per minute, is provided with a very heavy fly wheel, as its principal work is in driving millstones at a high velocity. There is a jet condenser and an air pump worked by an eccentric attached to the engine. The cylinders are fitted with radiable cut-off plates working on the backs of the main valves, that on the high pressure being adjustable by hand while the engine is at work. The piston rod, crank pin, and valve spindles are all made of steel, and the engine is well designed, having ample bearing surface and is one well adapted for high speed.

Messrs. Simpson & Co. are to be congratulated on having designed such an exceedingly neat and compact form of tandem engine, which not only occupies a small space in comparison to the power exerted, but is also very economical in steam consumption.—*The Engineer.*

THE SAINT ETIENNE TRAMWAYS.

THE Saint Etienne tramways offer some interesting peculiarities, both as regards the route followed and the mechanical traction adopted. As regards the route, it had to follow the roadways of a mountainous country where there were often gradients of $\frac{1}{16}$ inch to the foot, and curves of from 65 to 95 feet radius; and it is a truly curious sight to see these gradients climbed by little trains hauled by 15-ton locomotives.

At present the Company's rolling stock consists of 34 locomotives and 109 cars. The lines are three in



COMPOUND CONDENSING TANDEM ENGINES.

number, and have a total length of 23 miles. The rails are spaced 3·28 feet apart, and are flush with the roadbed (Fig. 2). The trains do not stop to take up passengers, but the latter get in at stations that are not very far apart.

The road comprises, as above stated, three distinct lines: the city of Saint Etienne, Saint Etienne to Firminy, and Saint Etienne to Saint Chamond and Rive-de-Gier.

The Rolling Stock.—The first engines tried were the Brown locomotives, built at Winterthur. In these engines the cylinders are placed above the frame, so as to be protected from the dust, and be within reach of the engineman. Motion is transmitted to the wheels through the intermedium of a vertical working beam. A second type of engines employed along with the preceding were built by the Metallurgic Society of Tubize. As these two styles of locomotive became incapable of answering the needs of the service, owing to the gradual development of the line, the company had to order new ones, and selected those of Carels' make, which have been employed with success at Lille and in Italy. These locomotives, which are more powerful than the old ones, are in service upon the Rive-de-Gier line, the roughest one of the whole system, and their operation up to the present has been satisfactory. They are very strongly built, have wide friction surfaces, and seem to be able to resist the strains due to the unevenness of the road and frequent and sudden stoppages. They have six coupled wheels, the middle one of which has no spring, so as to facilitate the turning of curves. The following are the principal dimensions (see engravings):

Diameter of cylinders		10·6	inches.
Stroke of piston		13·75	"
Weight on driving wheels		26,400	pounds.
" in running order		33,000	"
Heating surface	direct	27	square feet.
	of the tubes	263·5	" "
	total	290·5	" "
Number of tubes		70	
Dimensions of tubes		$1\frac{3}{5}$, $1\frac{4}{10}$	inches.
Maximum admission		0·75	
Effective power		80	horses.
Diameter of wheels		31·5	inches.
Distance apart of wheels		5·9	feet.
Capacity of water tanks		352	gallons.
Water in boiler		233	"
Capacity of coal bunkers		21	cubic feet.

The boiler is fed by means of two injectors. The position of the level of the water in the boiler when the engine is on a steep grade had to be studied with care, in order to prevent the top of the fire-box being uncovered. The level is shown in its extreme positions in the engraving. The apparatus for maneuvering the brake, F, is situated in the middle of the engine, and is readily accessible. The reversing gear, C, is double, as are the levers for maneuvering the regulator, R, etc., so as to permit the engineman to be always in the front of his engine, the latter never being turned around. The fire-box is of copper, as are the lateral braces, and the iron tubes have copper ends. A sand-box is placed on each side of the boiler.

These locomotives haul three cars up the steepest grades, and we would say just here that the track is not that of a railway, but that of a tramway, the rails being sunk in the ground, thus giving quite a high coefficient of traction. Finally, they are easily maneuvered. At the trials made at the time they were received, they were coupled to baggage cars weighing 24,200 pounds, and started upon a grade of $\frac{4}{10}$ inch to the foot with a velocity of from 12 to 16 miles an hour, when it was found that it was possible to stop them without the aid of the car brakes on a length of from 36 to 39 feet (instead of the 65 required by law, on a grade of $\frac{3}{10}$ inch, at a velocity of 12 miles). The maximum tractive power, measured at the coupling, is 4,990 pounds.

The cars are, all of them, without outside seats. The type principally adopted is that for 32 passengers, and having end platforms. Their length varies from 17 to 20½ feet, and their width is 6⅛ feet. Their maximum height is 13 feet.

In summer, the Company puts in service a certain number of open cars which are very much appreciated by the public. The seats of these have movable backs and are arranged crossways, and so as to leave a central passage. All the cars are provided with screw brakes, each of which is looked after by a brakeman.

The cars weigh from 5,500 to 6,600 pounds.—*Le Genie Civil.*

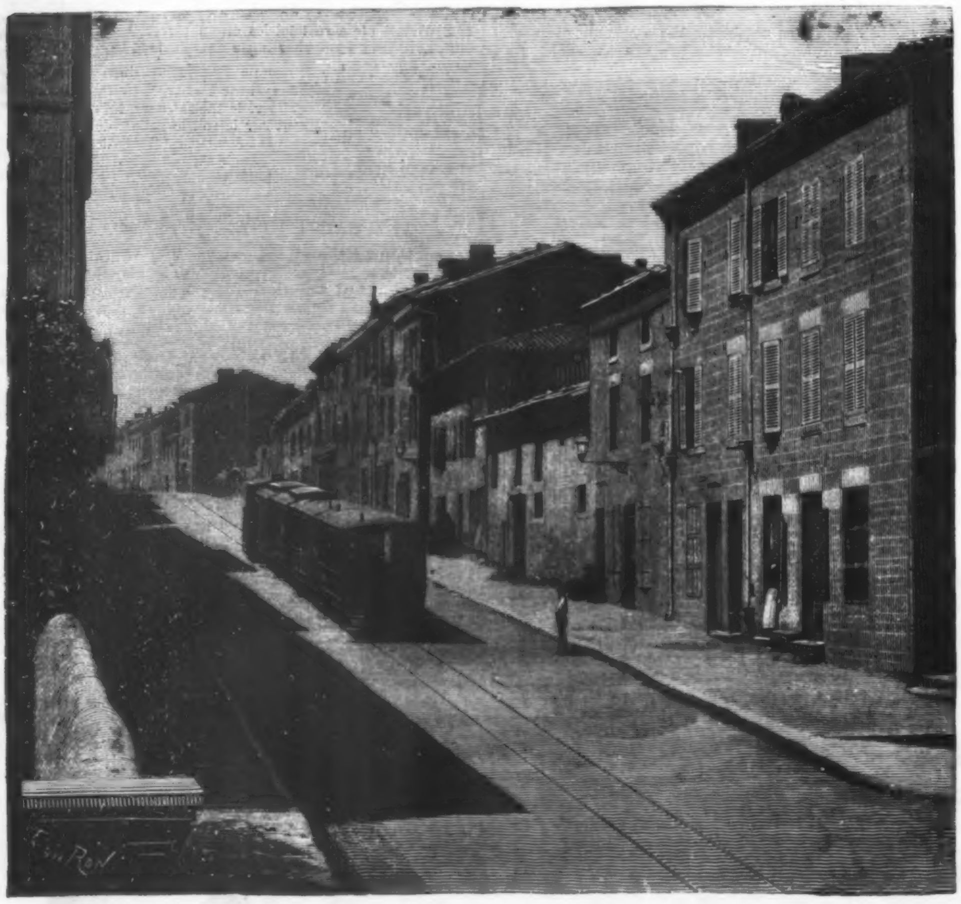


FIG. 1.—SAINT ETIENNE TRAMWAY. (View taken at Lorette.)

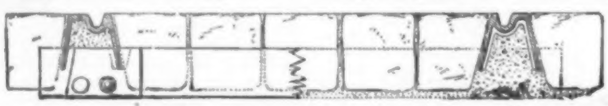


FIG. 2.—SECTION OF TRACK.

FIG. 3.—SAINT ETIENNE TRAMWAY.

SPRING MOTORS FOR VEHICLES.

THE subject of utilizing the power stored up in coiled springs naturally divides itself into two parts—making the spring and applying it. We find that the latter has been most thoroughly studied, the result being the production of devices which, taken as a whole, seem to cover every feature most satisfactorily. Particular attention has been paid to the propelling of vehicles by means of springs. We have mechanisms which turn to advantage the momentum of the vehicle in descending a grade or stopping; the difficulty arising from the decrease of force as the spring uncoils has been overcome; by combining several springs, sufficient power can be obtained to propel the car a long distance, and enable it to ascend a heavy grade while carrying a maximum load. Facilities have also been obtained for winding the springs and guarding against a loss of part of the power, which would result in the disabling of a portion of the machinery. These results have been attained in various ways, as will be seen from the following brief description of some of the more important inventions relating to this subject.

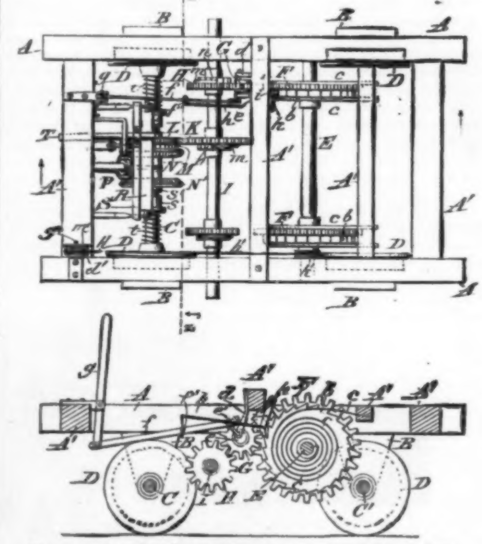


FIG. 1.—COLE'S SPRING CAR PROPELLER.

Springs of enormous power have been rolled and successfully tempered. Probably the largest one ever made was turned out by the Superior Iron and Steel Works, of Pittsburg, Pa., for the United States Spring Car Motor Company, of Philadelphia. It was 310 feet long, 6 inches wide, ¼ of an inch thick, and weighed 1,700 lb. But it is a question if steel springs of this size, having the requisite strength and durability, can be made except at an excessive cost.

Mr. Jacob H. Cole, of Danville, Pa., patented a device for propelling cars by means of springs so arranged that the car could be started and stopped, and the direction reversed, at will. The power shaft, E (Fig. 1), carries the cog wheels, F, each of which is formed with the ratchet, *b*, and is provided, on each side, with flat steel springs, one end of each spring being attached to the hub of the wheel while the other end is secured to the car frame. The cog wheels, F, gear with small cog wheels, G (the drawings only show one of the latter), journaled in a bracket attached to the frame. The small wheel is journaled on an eccentric shaft, *e*, provided with a crank arm, *e'*, attached to a rod connected with the lower end of the lever, *g*. The rod is formed with a pin, *f'*, which engages with the end of a bent rod, *h*, the opposite end of which is attached to a pawl, *i*, held in contact with the ratchet by a spring. The wheels, G, mesh with wheels, H, on a shaft which carries near its center a large cog wheel, K; these wheels are loose on the shaft, and are provided with pawls, *m*, by which they are connected with ratchet wheels secured to the shaft. The wheel, K, meshes with the wheel, L, which is attached to a wheel journaled loosely on the axle, C, and carrying a ratchet, M, and miter gear, N. An intermediate gear, P, connects the gears, N and N', the latter being loosely journaled.

Sliding on the axle and connected by feathers are clutch jaws, *s*, adapted to engage with similar jaws, *s'*, fixed to the wheel, L, and gear, N'. These clutches are operated by arms depending from a sliding bar, R, supported in a bracket attached to the frame. The bar is moved by a lever, T, so as to alternately open

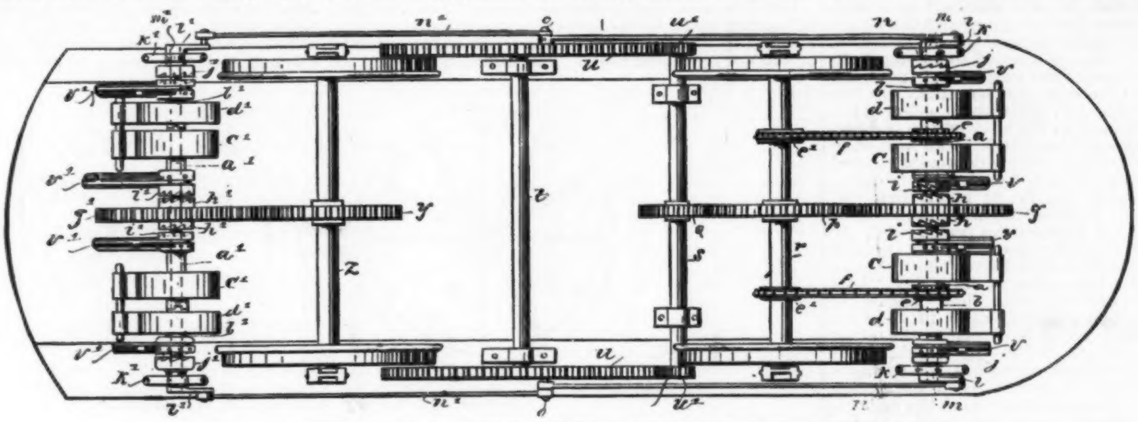


FIG. 2.—PLAN VIEW OF PUGH'S SPRING MOTOR FOR STREET CARS.

and close the clutches as required. A pawl is pivoted in the end of an arm for the purpose of engaging with the ratchet, M, so that when the lever, T, is thrown to the center in opening the clutches the engagement of the pawl with the ratchet will prevent the power of the coiled springs from being expended. The spring wheels are actuated by means of power applied to the

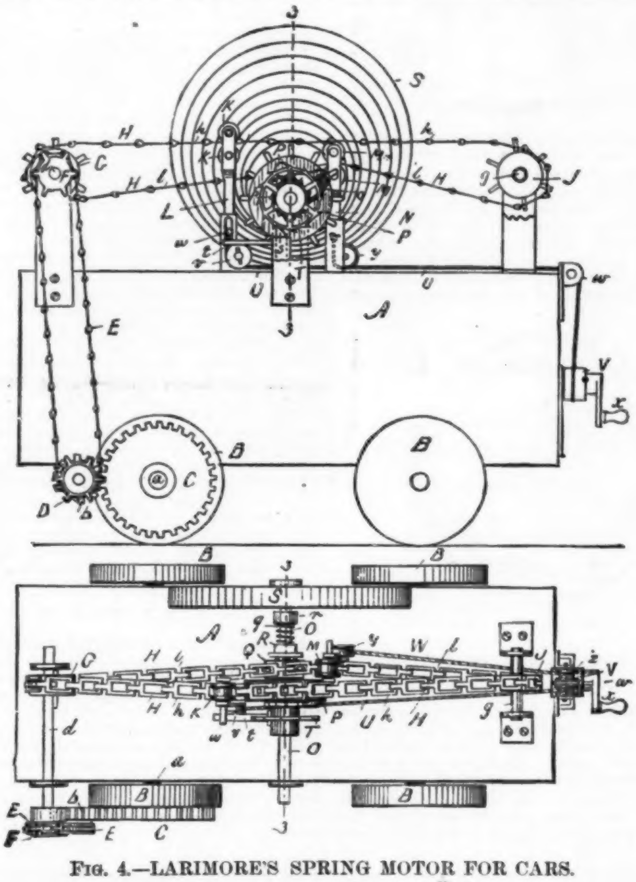


FIG. 4.—LARIMORE'S SPRING MOTOR FOR CARS.

projecting ends of the shaft, I, so as to coil the springs, *e*. It will be seen that by shifting any of the gears so as to disengage their pawls from their respective ratchets, a limited number of the spring gears, F, may be actuated; or all may be operated upon at once to coil any number of the springs according to the amount of power required. When the pawls, *t*, are retracted, the power of the springs is transmitted to the wheel, L, on the axle. By causing the lever, T, to bring the clutches, *ss'*, into engagement on the right or left side, the car will be propelled forward or backward as desired.

When the car is descending a grade by force of gravity alone, by throwing the lever, T, in a proper direction the various gears may be made to coact so as to partially wind the springs for further action. An index, *g'*, is so connected with the hub of one of the wheels, F, that it will indicate upon a dial, *m'*, the extent to which the power of the springs is exhausted.

In the device shown in Fig. 2, recently patented by Mr. Jesse B. Pugh, of Indianapolis, Ind., each spring employed in the motor can be wound up independently of the others; also, when stopping and when descending a grade, the momentum of the car can be utilized to

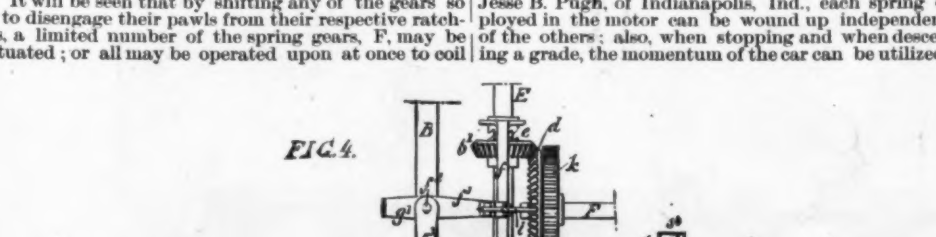


FIG. 3.—PFAUTZ'S SPRING MOTOR FOR VEHICLES.

partially wind up the springs. The drawing shows the under side of a street car furnished with this device. To the sleeves, *a*, *a'*, are attached steel coil springs, *c*, *c'*, *d*, *d'*. Each end of the sleeve is provided with clutches, *i*, *j*, working loosely on shafts extending across the car. The ends of the shafts carry the cranks, *l*, which are connected by rods, *n*, with the main gear wheels, *u*, by means of crank pins, *o*. Held firmly in position by collars, but revolving loosely on the shafts, are cog wheels, *g*, *g'*, on the sides of which are clutches, *h*, engaging with clutches, *i*, on the sleeves, *a*. The chain wheels, *e*, working loosely on the shaft, *m*, are connected with chain wheels, *e'*, mounted rigidly on the axle of the car, upon which are also mounted the cog wheels, *p* and *y*. Ordinary link levers are used in winding up the springs and in shifting the parts into gear. The springs in uncoiling impart a rotary motion to the sleeves, which carry with them the chain wheels, *e*, transmitting through the endless chains, *f*, motion to sprocket wheels mounted on the axle of the car. The speed of the car can be measured by shifting the springs, *c'* and *d'*, into engagement with the crank clutches, *j'*, and transmitting the power to the gear wheels, *u*, thence through pinions, *u'*, to shaft, *s*, and thence to the axle through gears, Q and P, thus bringing to bear the entire force of all the springs on the axle to impel the car. By shifting the clutches, the momentum of the car when stopping, and in descending grades, may be employed to wind the springs.

In an invention patented by Mr. D. M. Pfautz, of Philadelphia, Pa., a number of springs are employed, one or more of which may be applied to the axle as required. The rear axle is adapted to fixed bearings on the frame, and the front axle to bearings on a pivoted truck, D (Fig. 3), which can be adjusted by rack and pinion mechanism to facilitate the turning of curves. The spring motor devices for each axle are alike, but those for the rear axle are carried by the frame of the car, while those for the front axle are carried by and swing with the pivoted truck. On each side of the axle is a transverse shaft, E, which carries spur wheel, *a*, gearing with pinions, *a'*, on the axles. F are the longitudinal spring shafts, four of which are shown, two for each shaft, E, the latter being geared to the spring shafts by means of the beveled wheels, *b*, *b'*, and *d*. The beveled pinions, *b*, *b'*, can be secured to or released from the shafts by clutches, *e*. Thus when the pinions, *b*, are clutched to the shafts and the pinions, *b'*, are free the springs act through the shafts, F and E, upon the axle to move the car forward; and when the pinions, *b'*, are clutched to the shafts, and the pinions, *b*, free, the car will be moved backward. By throwing the pinions, *b'*, into gear the momentum of the car may be utilized to wind the springs.

The clutches are suitably connected so as to be operated by levers, G, on the front platform, the levers being hung to notched standards so that they can be retained in either of the positions necessary for the proper operation of the clutches. The spring shafts are prevented from rotating when both of the pinions are free from the shaft, E, by lock plates, *i*, which are so arranged as to engage with the teeth of the bevel wheels, *d*, when the pinions are free. To each spring shaft is secured a spur wheel, *k*, geared into a pinion, *k'*, of a winding shaft, H. The front springs are wound in a direction the reverse of the rear springs, and the winding shafts for the front springs are connected by gearing to those for the rear springs, and are operated by worm gearing from a transverse shaft, J, to which power is applied. The pinions, *k'*, are loose on the shaft, but can be secured to or released therefrom by clutches, *m*, moved by rods, *n*, connected to levers on the front platform. The bevel wheels, *d*, are connected to the shafts by pawl and ratchet mechanism, so that in winding up the springs they will not be rotated. The worm wheels, *p*, are united to the shafts, H, by clutches, *p'*. Each spring shaft is provided with an indicator, M, which will show at a glance the condition of the spring. An undue increase in the speed of the car is prevented by an automatic brake controlled by an ordinary ball governor actuating the lever of a friction brake strap. To overcome the loss of traction resulting from a wet or icy track, the inside of each wheel is provided with a number of radially guided rods pointed at the outer ends and connected at the inner ends by links to a sleeve sliding on the shaft and controlled by the driver through a system of rods and levers. On thrusting the sleeve toward the wheel, the pointed rods will be moved so as to project beyond the rim of the wheel and form spurs to increase the grip.

Fig. 4 is a drawing of a mechanism patented by W. T. Larimore, of St. Louis, Mo., designed to assist in starting a car and in ascending grades. The axle of one pair of wheels is provided with a gear wheel, C, with which meshes a pinion wheel, *b*, carrying a sprocket wheel, D, which is connected with a similar wheel, F, by an endless chain. The shaft, *d*, carries a second sprocket wheel, G, arranged to turn therewith and to slide lengthwise; this wheel is connected with the wheel, J, mounted loosely by an endless chain, H, one length of which passes between grooved rolls, K, and the other length between the rolls, M. The two posts

carrying these rolls may be moved vertically, and are arranged one upon each side of a transverse longitudinal shaft turning in bearings on the car body. This shaft carries a loose sprocket wheel, P, which is provided with a spring pawl, *o*, engaging with a ratchet of the shaft, and also another loose sprocket wheel, Q, in line with the post, N. On the shaft is a sliding clutch collar, R, arranged to engage with the wheel, Q, and held in engagement by the spiral spring, *q*. The spring, S, is attached to and coiled about the shaft. The wheel, P, is in line with the length, *h*, of the chain, and the wheel, Q, in line with the length, *l*. On the shaft is the ratchet wheel, T, with which engages the pawl, *s*, which is attached to the body of the car and has an arm, *t*, in position to be struck by an arm, *u*, of the sliding post, L, when the latter is depressed against its spring. A line, U, leads from the post, L, to the drum, V, which is turned by the handle, *x*; and a line, W, also leads to the drum. Turning the drum in one direction pulls the line, U, to depress the post, L, and in the other direction it depresses the post, N, through the line, W, and in either case leaves the opposite post free to lift under the action of its spring. The depression of the post, L, puts that length of the chain passing between its rolls in connection with its sprocket wheel, and places the other length out of connection. When the length, *l*, of the chain is connected with the wheel, Q, the spring is wound up; and when the length, *h*, is in connection with the wheel, P, the spring operates upon the car axle by its unwinding, the release of the pawl, *s*, being effected by the abutment of the arm, *u*, against the arm, *t*, of the pawl. It will be seen that in stopping and in descending grades the momentum of the car can be used to wind up the spring.

Mr. J. C. Hearne, of Pleasant Hill, Mo., patented a device for propelling hand cars or trucks for railroad or other purposes by means of coiled springs. Upon transverse shafts are mounted gear wheels which mesh with pinions secured to the axle. Alongside of these wheels are placed ratchet wheels in which pawls engage; the same shafts also carry coiled springs, one end of which is secured to the shaft and the other end to the car body. The springs are coiled by means of hand levers, the pawl engaging with ratchets as soon as the spring unwinds.

In an invention patented by Mr. Geo. S. Petry, of Troy Grove, Ill., the driving gear-wheel, the shaft of which carries the coiled spring, is placed between the axles of the car and suspended on a longitudinally sliding frame so as to engage alternately with pinions on either of the axles, thereby changing the direction or reversing the motion of the car when the driving wheel is disconnected with one axle and put in connection with the opposite one.

A novel mechanism for utilizing the power in a coiled spring has been patented by Mr. George E. Cliver, of Philadelphia, Pa. On the axle is a sleeve provided with a worm wheel, and which forms part of the casing containing the spring, one end of which is fixed to the inside of the rim of the case and the other to the sleeve. Sliding on a feather on the sleeve is a transmitting wheel, between which and the case is a spiral spring. Adjoining the transmitting wheel is an annular wheel which turns on the sleeve, and has gear teeth formed on the inner edge of its rim. Engaging with this wheel is an intermediate gear which transmits motion to the axle through a pinion. By shifting the transmitting wheel so that it engages an arm on the annular wheel, power is applied to turn the axle. Engaging with the worm wheel is an endless screw which is operated from a hand wheel at one end of the car to wind up the spring.

In a car propeller* invented by Messrs. Robert Steel and Samuel Austin, of Philadelphia, Pa., coiled springs are connected with a revolving shaft which has a geared connection with one of the axles of the track wheels. Near the middle of the axle is fixed a cylinder around which the clamping jaws of a brake to regulate the power of the springs are arranged. The brake consists of two crossing levers, having their connecting fulcrum secured to a stationary hanger fixed to the under side of the platform. The end of one lever is loosely fitted to the lower end of a screw-threaded standard, the upper end of which is provided with a hand wheel; the end of the other lever is threaded to fit the standard. By turning the standard the clamping jaws are caused to press upon the cylinder and arrest the rotary motion of the axle. To give an immediate start to the vehicle after each arrest, the axle is furnished with a ratchet wheel with which engages a pawl carried by a rod sliding along the under side of the platform and operated by means of a hand lever.

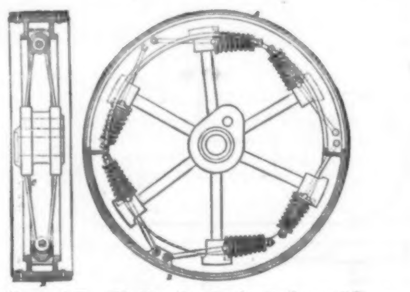
It will be seen that in consequence of the rotation of the spring shaft, all the springs connected with it have a simultaneous action, which is adverse to the capacity of a motor for a long route. This difficulty is overcome in an improvement patented by Messrs. George Stites, Robert Steel, and Samuel Austin, of Philadelphia, Pa. Combined with a stationary shaft is a series of drums carrying springs adapted to be brought into action connectively, either single or in sections, as may be desired; the single spring or section is of adequate power to propel the car with a maximum load, so that the consecutive action of the whole series will be sufficient for running it the round trip.

Additional illustrated articles upon spring motors of various designs, and applied to different purposes, can be found in the SCIENTIFIC AMERICAN SUPPLEMENT, Nos. 47, 48, 50, and 142.

* This mechanism is illustrated in the SCIENTIFIC AMERICAN SUPPLEMENT, No. 46.

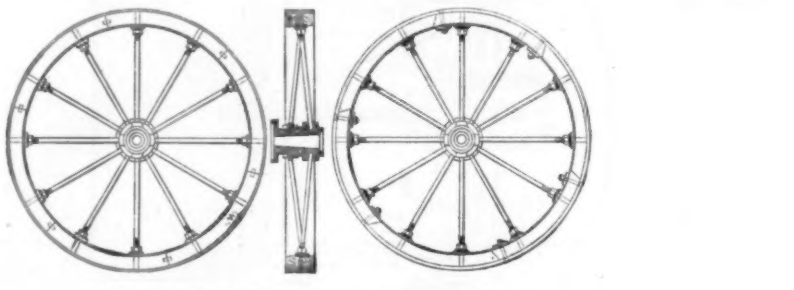
IMPROVED SPRING WHEELS.

AVELING & PORTER have simplified the construction by making the outer tire of cast instead of wrought iron. The wheel as now made is shown by our engravings, from which it will be seen that the outer tire is a single casting having a channel on its inner side to contain and guide the blocks cast on the ends of the spokes of the inner wheel. These blocks are cast on to double spokes, each double spoke being formed by bending a bar so that the bend is inclosed in the cast block. This is an improvement on the two separate spokes employed in former wheels, and insures a better combination of the spokes and blocks. These spoke blocks being placed in the channel of the outer tire with the spokes in their proper positions around the center of the wheel, the center boss is then cast on to the inner ends of the spokes in the usual manner. It will be noticed that from the manner in which the springs are arranged each pair of springs tends to force together the outer ends of the two arms against which they abut. To relieve the spokes from any bending strain due to this action, a cast-iron strut (not shown in our engravings) is introduced between the two spokes and bolted to the blocks at their outer ends. The boss and spokes, etc., having been connected as described, the springs and connections have only then to be placed in position to finish the wheel. By the adoption of the simple mode of construction just described, Messrs. Aveling & Porter have been able to reduce the cost of these spring wheels so much that their use now involves but a very small addition to the cost of the engine.



Section on A B. Side Elevation showing Section on C D.

SPRING WHEEL FOR TRACTION ENGINES.



COMBINED WOOD AND IRON WHEELS.

COMBINED WOOD AND IRON WHEELS FOR PORTABLE ENGINES.

THIS wheel is composed of a cast-iron boss, into which wrought-iron spokes are fused; these spokes are screwed, and furnished with nuts and plates at the outer ends, which there pass into wooden segments or fellies forming an elastic lining to a wrought-iron tire. These segments can either be framed together with radial joints as usual with wood wheels, and as shown in Fig. 1, or they may be beveled together as shown in Fig. 2, under which latter arrangement each alternate segment acts as a wedge between its neighbors. In either case the tire is heated and contracted round the rim in the way common to wooden wheels, the result being that the wooden segments are pressed tightly upon the collars and nuts around the spokes, which may nevertheless be adjusted further as may be found necessary from time to time. In the arrangement shown in Fig. 2, which is that to which Messrs. Garrett and Sons, of Leiston, give the preference, there are also provided countersunk headed bolts passing through the tire and wooden lining at each joint between the segments, which bolts afford a means of adjustment by the nuts and collars operating upon the inside of the wooden lining. In either case (Fig. 1 or 2), however, Messrs. Garrett contend it will be found possible to tighten up the wooden lining quite sufficiently to compensate for any shrinkage of the wood or extension of the wrought-iron tire by the "drawing" action in traveling over rough hard pavements, so that it will never be requisite to shorten and reheat the tire. Messrs. Garrett and Sons inform us that they have had three years' experience with a set of wheels made on the plan shown by Fig. 1 of our engravings, and that they have given very satisfactory results, the wooden rim affording an elasticity which is wanting in some forms of iron wheels.—*Engineering*.

THE DUTTON SLUICES.

EXTENSIVE and interesting works have been carried out in connection with the River Weaver Navigation. Of these, the sluices at Dutton are among the most recent, and from their magnitude are works of considerable importance They were built to replace two weirs, and they have had the effect of raising the level of the water 4 ft. 3 in. The construction of the sluices was rendered advisable on account of the frequent and sudden flooding of the adjacent land, which it was of course necessary to prevent by providing an outflow for the surplus water, while maintaining sufficient depth for navigation.

THE DUTTON SLUICES, RIVER WEAVER NAVIGATION.

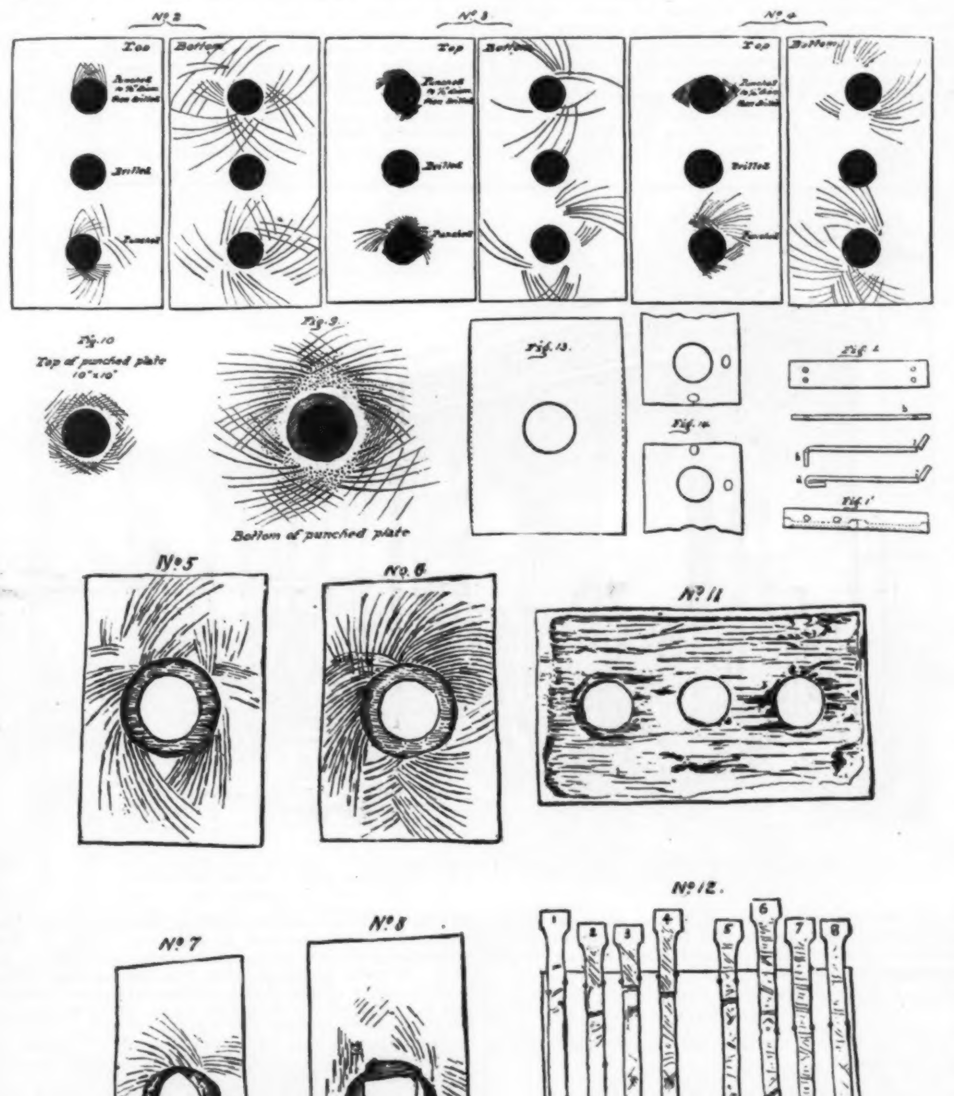
We publish a general view of these sluices, of which there are eight, each of fifteen feet opening. The structure spanning the river is of Runcorn sandstone and Anglesea limestone, and the piers are founded on concrete carried down to the marl. On the platform between the piers, rails are laid, on which runs a treble-geared traveling crane employed to raise the sluices. At the back of each of the sluices are four rollers working in recesses in the masonry, and which thus greatly lessen the friction as the gates are raised; the joints are made good with suspended packing pieces of heavy wood, which are forced into position by the water, and maintain the joints tight. Arrangements are provided at each of the end sluices for relieving any excessive accumulation of water or ice, by extra doors moving on hinges.

During the time that these sluices have been in operation, they have worked extremely well, and fully answered the purpose for which they were designed by Mr. Lionel B. Wells, engineer of the navigation.—*Engineering.*

ON THE INFLUENCE OF PUNCHING HOLES IN SOFT STEEL.*

By V. N. BECK GUERHARD, Russian Mining Engineer, Government Inspector of the Russian Rail Works.

I LATELY conducted various experiments at the Poutiloff Works (St. Petersburg) respecting the influence



PUNCHING HOLES IN SOFT STEEL.

of punching holes in soft steel, which will be of some interest to the readers of the *Mining Journal.*

The experiments commenced by testing nail fish plates (which are now proposed to be made from mild steel), in order to ascertain if the resistance of the fish plates will be decreased by punching instead of drilling the bolt holes.

For this purpose 42 fish plates were cut from the same bars of the same mild steel containing from 0·1 to 0·15% carbon, and the bolt holes, in the same number and of the same dimensions, were drilled in the first 14 plates, cold punched in the second 14, and in the last lot of 14 plates they were punched after heating the plates to a dark red heat.

To these fish plates short pieces of rails were fastened, and the 21 joints so made, 7 with drilled plates, 7 with cold punched and 7 with hot punched holes. These were tested under a pressure of=600 pounds, 9·7 tons, the distance between the supports being 3' 6". The whole pressure was supported only by the fish plates, as the upper part of the rail heads was so cut that they could not touch each other even in the maximum of deflection. The deflections are shown in the following table:

Joints with Drilled Holes.		Joints with Cold Punched Holes.		Joints with Hot Punched Holes.	
Temporary Deflection.	Permanent Deflection.	Temporary Deflection.	Permanent Deflection.	Temporary Deflection.	Permanent Deflection.
39·15	33·95	49·00	43·55	61·90	56·50
50·00	44·00	47·85	42·35	46·20	42·00
43·90	38·15	52·60	47·00	57·25	52·00
47·15	41·10	42·30	37·00	49·50	44·00
56·20	50·00	49·85	44·00	47·20	42·75
53·20	48·25	40·35	35·50	61·00	55·50
46·10	40·80	43·35	38·10	57·00	52·30
47·80	42·30	46·47	41·00	54·00	49·00

When, after this, 20 other fish plates were made from a steel containing 0·05 per cent. more carbon (and the holes punched hot), the 10 joints made with them were tested under the same condition as the former, and showed the following deflections:

Temporary Deflection.	Permanent Deflection.
28·00	25·00
26·50	21·30
24·35	20·25
29·00	24·30
26·10	21·25
25·00	20·35
27·00	22·50
25·85	23·20
25·50	21·15
27·25	22·80

All the joints tested under a pressure of 600 pounds=9·7 tons were afterward tested under a pressure of 900 pounds=14·5 tons, and not one fish plate showed cracks or any other sign of deterioration. The above described tests proved that punching holes cold in such a soft steel (from 0·10 to 0·15% carbon) does not practically affect the fish plates, and that a very little increase of hardness—viz., carbon, has much more influence on the resistance of the joints than the manner in which the holes were made.

For the next experiments trial bars 10 in. long by 1 in. wide were made from mild steel ½ and ⅝ in. thick; from each plate 6 bars were prepared; the first was left untouched, in the second a hole ½ in. diameter was drilled, in the third a hole ½ in. diameter was punched cold, the fourth the same as the third but annealed, the fifth was punched with a ½ in. hole hot, and in the last a ⅜ in. hole was punched cold but afterward drilled to ½ in. in diameter.

These bars were tested for tensile strength, and the results are shown in the following table; elongation is measured on 8 in., and the breaking strain is in tons per sq. in.:

			Per Cent. Elongation.
1st series mild steel containing 0·12 carbon.	Bar untouched	26·82 T. □".	0·25
	" drilled	25·75	5·07
	" cold punched	23·04	3·0
	" cold punched annealed	28·88	5·07
	" hot punched	27·08	5·07
	" punched and drilled	27·40	5·31
2d series mild steel containing 0·12 carbon.	Bar untouched	31·59	19·58
	" drilled	30·96	4·57
	" cold punched	27·05	0·88
	" cold punched annealed	31·98	4·57
	" hot punched	30·71	3·59
	" punched and drilled.	31·15	4·57
3d series mild steel containing 0·12 carbon.	Bar untouched	25·67	26·72
	" drilled	25·27	5 807
	" cold punched	24·07	3·83
	" cold punched annealed	27·09	5·31
	" hot punched	26·47	6·3
	" punched and drilled	26·61	5·8
4th series mild steel containing 0·12 carbon.	Bar untouched	32·22	24·01
	" drilled	30·39	4·57
	" cold punched	26·53	3·59
	" cold punched annealed	30·26	3·83
	" hot punched	30·26	3·35
	" punched and drilled	32·15	4·33
5th series mild steel containing 0·12 carbon.	Bar untouched	29·7	25·0
	" drilled	28·8	5·3
	" cold punched	26·1	3·3
	" cold punched annealed	29·2	5·3
	" hot punched	29·3	5·8
	" punched and drilled	30·3	4·0
6th series mild steel containing 0·12 carbon.	Bar untouched	29·1	26·0
	" drilled	28·6	5·8
	" cold punched	26·9	2·8
	" cold punched annealed	28·9	5·8
	" hot punched	29·0	5·3
	" punched and drilled	29·9	5·3
7th series spring steel containing 0·3-0·5 carbon.	Bar untouched	55·0	12·7
	" drilled	43·9	0·88
	" cold punched	30·3	0·39
	" cold punched annealed	47·6	0·65
	" hot punched	46·0	0·88
	" punched and drilled	47·2	0·64
8th series spring steel containing 0·3-0·5 carbon.	Bar untouched	53·8	14·42
	" drilled	44·4	0·64
	" cold punched	34·4	0·39
	" cold punched annealed	48·67	1·13
	" hot punched	49·61	1·13
	" punched and drilled	47·06	0·64

These tests show that punching cold compared with drilling decreases both resistance and elongation—that annealing cold punched bars and hot punching are nearly equivalent, and that the after-drilling of a cold punched hole reduces the influence of punching.

In order to ascertain the influence of punching, if the hole is punched not in the bar itself, but close to it, two trial bars were cut (as shown in Fig. 1) from a fish plate, in which in one-half 2 holes were punched, the other half remaining untouched. The drilled half of the bar gave 32·29 tons with 22·5 elongation, the untouched half of the bar 30·55 tons and 26·7 elongation, viz., the hardness of the metal was increased in the neighborhood of the punching.

The third experiment was the following: At the ends of a bar of mild steel holes were punched as shown in Fig. 1 (*a* and *b*), after which the ends were bent, one end in the direction of the punching, downward (*b*), the other in the opposite direction (2).

The end, *b*, could be bent to a right angle without showing any cracks, and sometimes flat, as shown in *d*, whereas the end, *g*, always showed large cracks before being bent to a right angle.

This test I have repeated in several works, and have obtained the same results.

The same test made with the same bar, but with drilled holes, gave other results. Both ends can be bent upward and downward without cracks, and the difference between the top and bottom of the holes cannot be seen, neither in welded iron does it occur.

This fact induced the study whether microscopical cracks are not formed on the bottom of the punched holes, which is rejected by Barba in his "*Etude sur l'emploi de l'acier*," but still admitted by many engineers.

For this purpose a large quantity of small plates were prepared 5"×3"×⅛" of steel of different hardness, with shaped sides and polished surfaces, and in those plates three holes ¾" diameter were made, the one drilled, the second punched, and the third punched ⅝" and then

* Translated from the Russian *Mining Journal* for, and furnished *Engineering News* through the courtesy of Theo. Cooper, C.E.

drilled to ⅛", after which the edges of holes were examined under the microscope.

In no one of the large quantity of plates of steel examined of different hardness (from 0·1 to 0·6 c.) have I found cracks or flaws. In the drilled holes the edges under the microscope are also clean enough. In the punched holes only the top side is clean, shown a round edge, while the bottom side presented a sharp edge, in some places broken away, and drawn out with deep cavities discovering the crystalline structure of the metal. In short, under the microscope we see a clear picture of the rough destruction caused by the punching.

The inside of the holes is smooth for one-third of the length, with visible traces of the friction of the punch; the remaining two-thirds is of larger diameter, with two or three cracks broken off.

Instead of the microscopical crevices which I looked for, I discovered another interesting phenomenon, which, as far as I know, has not yet been described.

On the smooth polished surface of my plates, around the punched holes, appeared clearly visible to the eye (without a glass) a design composed of curved lines, disposed like bundles or sheets, more or less tangential to the circumference of the hole, and crossing each other.

These lines, shown on Figs. 2, 3, and 4, presenting correct printing in lithographs from photographs 5, 6, 7, and 8, do not appear around the drilled holes, but around the punched and the after-drilled holes they appear with the same clearness as around the holes punched to the full diameter.

In puddled iron plates I have not observed those lines. Remarked in the softest ingot metal, they were less visible in steel containing 0·5 of carbon, and finally with 0·6% carbon they could not be remarked.

With the increased thickness of the plates the number and clearness of the lines increased, as is seen by comparing Figs. 2, 3, and 4 (thickness ⅜") with photographs 5 and 6 (thickness 1").

The shape of the holes, as is seen in the photographs, has also some influence on the disposition and dimension of the lines.

On all the small plates, 5"×3", the lines appeared as very small but still visible indentations. On the large specimen, 10"×10" the lines were convex, gradually lowering to the end of the rays (different lines), and imperceptibly flowing together with the surface of the plate.

In the small specimens (3"), lines reaching the edge were terminated with a plain surface; whereas in the specimens with unplaned edges, such as fish plates, the most developed lines were visible beyond the edge of the specimen, and after crossing the lines projected in some cases on the opposite side of the plate.

In all the samples the lines around the top of the hole were less developed, thinner, and shorter, being sometimes disposed in small ripples and sometimes quite absent, changing into a characteristic dull-colored metal around the hole.

After heating and cooling, the lines did not disappear; they were, however, less distinct.

In order to determine how far from the hole the lines develop, a mild steel plate 10"×10½" thick was prepared with polished surfaces, and in the middle of it a hole of 1" was punched.

Around the hole we obtained a very clear design, shown in Fig. 9 from the top and in Fig. 10 from the bottom, the lines being convexed, so that they could be felt with the finger.

After copying the design, the surface of the plate was corroded with acid, after which appeared a notable quantity of bubbles, as shown in Fig. 11, taken from another plate.

After the action of the acid all the convex lines disappeared, being eaten away by the corrosion.

In order to see if the punching of the hole or the lines have an influence on the resistance of the metal, and how far this influence acts, the plate was cut (on a shaping machine) in 8 bars, 4 from each side of the hole, the bars tested gave the following results:

From the left side (extreme end) breaking strain:

No. 1	" " 26·98 tons, elongation	22·7	per cent.
No. 2	" " 25·46 " "	19·0	"
No. 3	" " 27·20 " "	19·0	"
No. 4	" close to the hole "	27·43	"
From the right side, near the hole:			
No. 5	" " 27·66 tons, elongation	20·4	"
No. 6	" " 27·67 " "	26·8	"
No. 7	" " 25·64 " "	19·54	"
From the right side extreme end:			
No. 8	" " 28·22 tons, elongation	19·09	"

On examining the broken bars, we remarked that the fracture corresponds with the blow holes or bubbles, that the difference in the resistance and elongation is influenced by the same cause, and that such defects in the ingot are much more serious than the influence of the punching. Further, we remarked that the surface of the broken bar, which was before smooth, appeared covered with convex lines, or small ribs, which could be felt with the finger.

Putting the broken bars together in the same order they occupied in the plate (they were numbered before cutting) as shown in photograph 12, it appeared that the separate lines gave the same design as on the plate before the corrosion with acid, viz., the same lines reappeared at the same places, but were more developed, and accompanied by other lines which were not seen before.

In order to test this fact, another similar plate was prepared from the same sheet, and cut into eight bars, but without punching before the hole. After fracture the eight bars still showed the same smooth surface, without the slightest line.

This test clearly shows that the lines on the plates, on being annulled by pressing out, and reappearing after the tension of the bars, depend upon the strain in the metal caused by the punching of holes in the sheet. This reappearance of the prominent lines after rupture of the bars shows that the metal evidently expanded more between the lines than in those parts of the bars which were covered with lines before the punching out, viz., that in the places covered with lines the metal became harder and less elastic, which is the reason that these parts projected more than the other parts, which had expanded more.

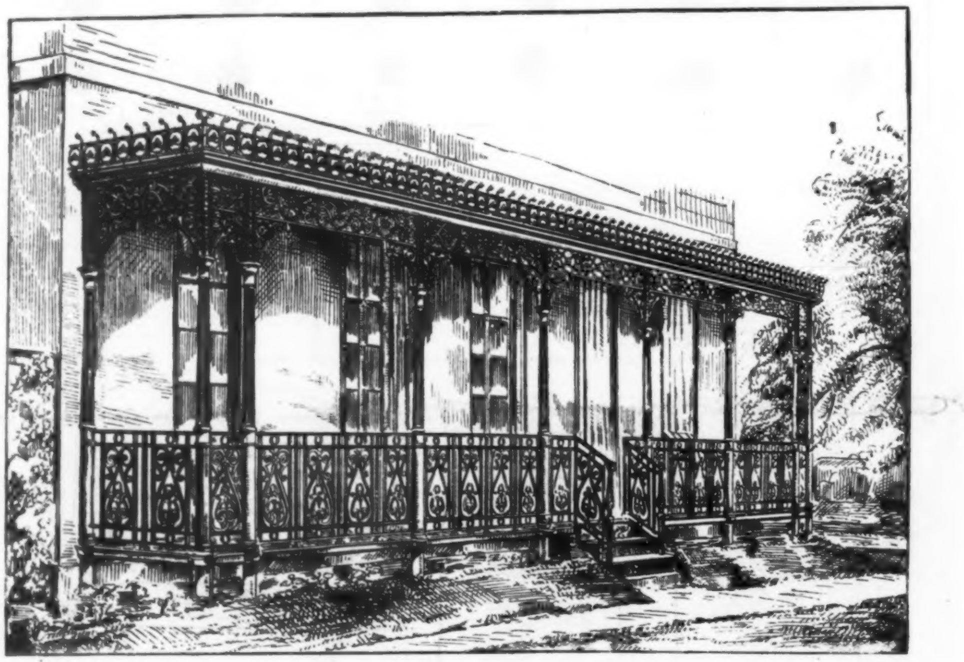
The appearance of fresh lines on the broken bars beside those observed on the plate before it was punched can be explained either by the lines having previously existed, but in the form of prominences invisible to the eye, or that they did not exist, and that the expansion was only caused by the punching of holes, which expansion occasioned the formation of the lines described, but to a very slight degree insufficient for their apparent formation—a formation obtained only after considerable tension of the softer parts of the metal between the invisible lines of compression.

In completing this description, I must state that I consider the experiments made by me far insufficient for an exact scientific explanation of the causes and laws of the results I have observed.

To my regret I have to discontinue any further experiment, owing to the want of time, and not wishing to take advantage of the kindness of the administration of the Pontiloff Works. However, judging by the results of the experiments made, I consider that the cause of the lines observed by me can be accounted for by the displacement of the molecules of metal (in connection with its crystalline formation and the degree of its hardness), caused by the compression of the same under the punch and its distribution from under the punch into the surrounding mass.

Barba states that the compression of metal when punched can temper the ring round the punched hole much more than it would be by putting into water a red-hot ring turned out of the punched circle; and another authority, Treska, describes the process of distribution of metals.

It is possible that, in continuing my experiments, I might have arrived at quite a different conclusion, but the fact that the punching of holes causes a very important forcing power is evident to me by the two following facts: (*a*.) The sides of rectangular plates expand, as shown in Fig. 13 (taken from nature) after a hole being punched in the center—the bottom part of the plate expanding more than the upper. (*b*.) If two holes are bored in a plate on two perpendicular lines, and at the point of contact of the lines a large hole is punched at an equal distance from the hole bored, as shown in Fig. 14, then the bored holes will be transformed from circles into a flat and elliptical shape, whereby the flattening on the top will be much less than the bottom of the hole, and more in the length of the fiber than across it.



SUGGESTIONS IN ARCHITECTURE.—A VERANDA.

A VERANDA.

OUR illustration of architectural ironwork is from the *Building News*.

ON JAPANESE CAMPHOR OIL.

By H. OISHI.

LAURUS CAMPHORA, or Kusu-no-Ki, grows in Japan, mainly in those provinces in the islands Shikoku and Kiushiu which have the southern sea coast. It also grows in Kishiu.

The amount of camphor varies according to the age of the tree. That of a hundred years old is pretty rich in camphor.

In order to extract this, such a kind of the tree is selected, and its trunk, stems, etc., are cut into small pieces and introduced into a wooden tub, A, having a false bottom. This tub stands over an iron pan containing water, which is heated by a furnace, C, below, as represented in the figure. The steam arising from the pan passes into the tub, where it meets with the cut pieces of the wood, and carries the vapors of camphor and oil together into a condenser, *a*, by means of a bamboo pipe. Here all the camphor and oil, together with steam, are condensed, while the uncondensed portion of steam escapes into the air through a pipe attached to the corner of the condenser. The latter is made of a wooden trough which is surrounded by another one, *b*, filled with cold water. In order to expose a large surface to perfect condensation of the vapors, the condensing trough is fitted internally with a number of vertical partitions which are open at alternate ends, so that the vapors may travel along the partitions in the trough from one end to the other.

The continual supply of water is made by a pipe from which it flows into a wooden trough, *c*, placed just over the condenser. From the upper trough the water flows into the lower one, *b*, thus keeping the condenser cool all the time.

One operation requires about 20 hours. After that time the contents of the tub are withdrawn, dried, and used as fuel. A new charge is then introduced from the top of the tub, after which it is well closed and the distillation is again commenced.

To supply the water into the pan, it is better introduced from the top of the tub, before the charge is taken out; by this means the water in passing down through a heated layer of the wood becomes itself heated, and thus shortens the time of heating in the pan.

As the distillation begins, a semi-solid mixture of the camphor and oil generally accumulates between the partitions in the trough, floating above the condensed water. The camphor and oil thus accumulated in the trough are taken out after several charges, usually 5 to 10 days. The quantity of the yield varies greatly in different seasons. The solid camphor is obtained much more in winter than in summer, while the amount of oil is just reverse. In summer time, from one charge consisting of 120 kilos. of the wood, 2·4 kilos of the camphor are obtained in one day, while in winter from the same amount, 3 kilos. of solid camphor can be obtained in the same time. In summer, from the semi-solid mixture obtained during 10 days, 18·04 liters of the oil are obtained, while in winter only 5 to 7 liters are obtained.

The oil, which contains in solution a considerable quantity of camphor, was formerly regarded as useless, but three years ago a method was devised which consists in distilling the oil and cooling the distillate. The arrangement of the apparatus is as shown in the figure.

The crude oil is introduced into iron kettles, *a*, *a*. Each of them is provided with a stopper having two holes; one is for inserting the delivery tube, and the other is for introducing the crude oil during the operation. The vapor passing through spiral tubes made of brass, and kept cool by water, is condensed and the oil is received into suitable vessels, which when full are taken away and cooled by surrounding with a fresh quantity of cold water. By this means the camphor separates out as a semi-solid mass, and in order to separate the solid camphor from the oil, the liquid is filtered or squeezed out through a cloth bag. The oil thus separated still contains a certain quantity of solid camphor. In order to remove this, it is again mixed with a fresh quantity of the oil and distilled as before. In this way 173 kilos. of the crude oil yields 36 to 45 kilos. of solid camphor; thereby the volume of the original oil becomes about a half. The purified oil, or that which is freed from the camphor, is used as a lighting material by the lower people of the province.

The purified camphor oil is a colorless liquid, and burns with a bright smoky flame; the general properties resemble very much those of the solid camphor. Crude oil has specific gravity 0·959, and the purified oil has 0·895 at 15° C. By oxidation in the air, or by nitric acid or by oxygen, a change in the composition occurs, and it produces ordinary camphor, together with certain higher oxyhydrocarbons, and the oil gradually becomes yellow. The oil dissolves many resins, such as gum mastic, gum elemi, colophonium, etc.; it dissolves asphaltum, sulphur, and many other things.

Reactions with acids:

Hydrochloric acid separates the oil into two layers, the upper one being transparent; the lower one is turbid. Nitric acid separates the oil also into two layers, the upper being yellow and the lower being colorless, but on heating it becomes a reddish liquid, which after some time again separates into two layers, but the oil suffers oxidation. When sulphuric acid is added, the oil is dehydrated, leaving a liquid smelling like terpene; when added in a large quantity, the oil is charred.

When chlorine is passed slowly into the oil, it is absorbed with elevation of temperature and evolution of hydrochloric acid fumes; the oil is thus changed into a yellow liquid. When excess of chlorine is passed, the oil becomes viscous. This semi-solid substance does not smell like camphor oil. With bromine the same reactions are produced, and when excess of bromine is added a red amorphous substance is formed. The oil dissolves a large quantity of iodine, and when heated becomes dark red. This dark red liquid when cooled below 0° C. becomes a semi-solid mass.

The specific rotatory power of the oil was examined by Solie's saccharimeter, and was found to be 68·96°, while the calculated value for $[a]_j$ is 68·29°.

To separate the oils of different boiling-points, the original camphor oil was subjected to fractional distilla

tion. The following is the result of distillation, using 200 c. c. of the oil:

Temp. of Distil.	Vols.
35 to 150° C.	12·0 c. c.
150 to 155	5·5
155 to 160	3·6
160 to 162	9·0
162 to 164	7·3
164 to 166	6·0
166 to 168	6·9
168 to 170	10·0
170 to 172	13·6
172 to 174	14·5
174 to 176	21·8
176 to 178	12·7
178 to 180	12·7
180 to 182	9·0
182 to 184	11·8
184 to 186	5·0
186 to 188	4·0
188 to 190	3·6
190 to 198	4·5
Residue	25·0
Total	188·5
Loss	1·5

All the distillates afford nearly the same reaction with the reagents.

The analysis of the distillate between 180° to 185° gave following result:

C	78·87
H	10·73
O	10·40 by difference.

The composition thus nearly agrees with that of ordinary camphor.

After repeated distillations he gave the following analysis of the fraction between (178 to 180)[3]:

$$C=86{\cdot}95 \text{ and } H=12{\cdot}28.$$

Thus it is a hydrocarbon.

(Exponent 3 means that the distillation was done three times.) The vapor density of the hydrocarbon was found to be 5·7; its molecular weight is therefore 164·4. We have then the necessary data to ascertain its molecular formula:

$$\frac{164{\cdot}4 \times 12{\cdot}28}{100} = 20{\cdot}18 = H_{20}.$$

$$\frac{164{\cdot}4 \times 86{\cdot}95}{100} = 11{\cdot}91 = C_{12}.$$

The formula is therefore $C_{12}H_{20}$; thus it is a hydrocarbon of the terebene series, having the general formula C_nH_{2n-4}.

The appended table will show clearly the nature of different distillates and resemblance of the oil to the ordinary camphor.

From these experiments it appears that the camphor oil is a complicated mixture consisting of hydrocarbons of terpene series, oxyhydrocarbon isomeric with camphor, and other oxidized hydrocarbons.

The distinguishing property of the camphor oil, that it dissolves many resins and mixes with drying oils, finds its new application as solvent for varnish. He tried in various ways with different resins and drying oils, and obtained rather a satisfactory result.

1. When colophonium, liquid balsam, gum elemi, or gum mastic is respectively melted in a porcelain dish and mixed with camphor oil, stirring all the time, each of them completely dissolves, and, when cooled, a heavy liquid is obtained, which may be used as a varnish. In applying this as a varnish it should be slightly warmed. This varnish, when spread over foreign paper and slightly warmed, makes the paper very transparent. Japanese paper soaked in the same also becomes very bright and transparent.

2. When a little turpentine oil is mixed with the resin solution in the oil, the varnish dries much more quickly, and assumes a brighter surface. The turpentine oil should be added after the resin is dissolved in the oil.

After various trials, the following mixture was found to be the best:

Camphor oil	10 grms.
Turpentine oil	3·3 "
Resin	8·0 "

3. When mixed with linseed oil, the same result as above is obtained, but this varnish does not dry so quickly as the second one, so that the varnished object requires slight warming in order to dry it completely.

4. Since the camphor oil dissolves dragon's blood, gamboge, the varnish may be colored red or yellow. Little alcoholic solution of aniline-red, purple, and blue were respectively mixed with the resin solution and coated on paper, and on drying in sunshine the first two colors disappeared, but the last remained as a fine blue.

5. When camphor oil is added to melted asphaltum, stirring all the time, a good varnish is obtained, which, when coated upon metallic surface and dried, produces very fine bright surface just like Japanese urushi. The best proportion is 22 grms. of oil to 5 grms. of the asphaltum.

6. The mixture of camphor oil with linseed oil or rapeseed oil produces a kind of varnish which when coated upon paper makes it water-proof. The best water-proof paper is obtained by using the solution of aluminum palmitate in camphor oil.

First, the paper was coated with a thin solution of the palmitate; this, after being dried, is again coated with more concentrated solution, and dried; when the third coating is done the paper becomes stronger, and capable of resisting the action of water for more than thirty-five hours.

Soot has somewhat an extensive application, being used for making inks, paintings, and coloring walls, etc. The soot obtained from the camphor oil is one of the best qualities, and is used for making the best kind of our solid ink. It is therefore important to see how much soot can be obtained from a certain definite quantity of the oil, and whether it can be got profitably or not. The first method consisted simply in burning the oil and putting a cold metallic plate over the flame, and collecting the soot deposited; by this means 7·5 grms. were obtained from 100 c. c. of the oil. When presenting this black to a certain dealer, the author was informed that the soot under question is next to the best quality, and that its price may be 35 cents per 375

Fractions.	Alcohol required to dissolve 1 part of the Oil.	Specific Gravity at 15° C.	[α] of the Chloroform Sol. containing 25 p.c. of the Oil.	Vapor Density.	Percentage composition.	Formulæ deduced.
45 to 156° C.	10·0	0·8655	66·02	—	—	—
156 160	9·0	0·8397	—	—	—	—
160 162	8·0	0·8400	66·02	5·29	—	$C_{11}H_{18}$ (?)
162 164	8·0	0·8580	—	—	—	—
164 166	7 4	0·8575	—	—	—	—
166 168	6·9	0 8525	—	—	—	—
168 170	6·1	0·8556	66·66	—	—	—
170 172	5·4	0·8615	—	—	—	—
172 174	4·4	0·8586	—	—	—	—
174 176	3·9	0·8636	—	—	—	—
176 178	2 8	0·8650	66·02	—	—	—
178 180	0·8	0·8745	72·51	5·70	C = 86·95, H = 12·28	$C_{12}H_{20}$
180 185	0·5	0·9260	—	—	C = 78·87, H = 10·73, O = 10·40	$C_{10}H_{16}O$
220 230	—	—	—	—	C = 78·20, H = 9·25	—
250 260	—	—	—	—	—	—

grms.; the quantity of the oil required to produce it is 5 liters, calculated from the experimental result, and the price of 5 liters of the oil is 27·8 cents.

In the second experiment the oil was burnt in the

FIG. 1.

One charge consists of 32 grammes = 120 kilos.

Boiler, 3 shaku in diameter. Wooden tub, 2·8 shaku in lower diameter and 1·5 in the upper, and 4 shaku in height.

same way, but within a metallic cylinder, whose bottom has many holes for admission of air. From 100 c. c. of the oil 13 grms. were obtained; therefore, only 3 liters of the oil are necessary to obtain 375 grms.

Three liters of the oil cost 16·7 cents, and produce 375 grms., costing 35 cents; thus there is an excess of 18

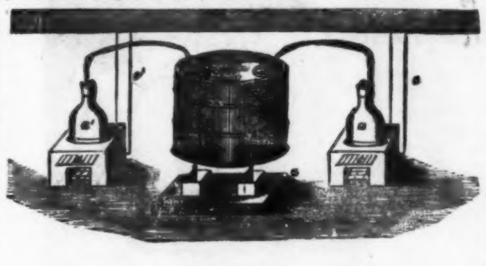


FIG. 2.

cents over the cost of the oil required. From this it may be said that the soot can be profitably prepared from the camphor oil.

The following is the report on the amount of annual production in Tosa:

10th Year of Meiji (1877).

Amount of camphor produced	504,000 kins.
The total cost	65,520 yens.

11th Year of Meiji (1878).

Amount of camphor produced	519,000 kins.
The total cost	72,660 yens.

12th Year of Meiji (1879).

Amount of camphor produced	292,890 kins.
The total cost	74,481 yens.

13th Year of Meiji (1880).

Amount of camphor produced	192,837 kins.
The total cost	58,302 yens.

—*Chemical News.*

THE WORLD'S FIRST MERIDIAN.

By RICHARD A. PROCTOR.

DESPITE the opposition of the French, Brazilian, and Haytian astronomers (a rather singular combination), the meridian of Greenwich has been adopted as the astronomical and geographical reference meridian for the world, and hereafter we may expect uniformity to prevail in maps and charts, in nautical almanacs, and in tables of reference alike for terrestrial and celestial computations. Of course, there will be no noteworthy change in the ordinary measurement of time in different countries or cities. At New York and Washington, for instance, where when it is noon in England it is only about seven in the morning, and only seven in the evening when it is midnight in England, they will not, because of the adoption of the Greenwich meridian, call it noon or midnight when the sun gives them so different a time of day. Ordinary or civil time will always be reckoned pretty nearly by the sun—not exactly, of course, for the simple reason that in that case every journey east or west would involve a change of clock time. Just as Ireland has a different time from England, not because of any native cantankerousness on either side of St. George's Channel, but because the sun gives different hours, so in the United States they must have their clocks and watches agreeing tolerably well with the sun, and so must have different local time from ours. In different sections of the States they will have, also, times differing by a full hour—earlier and earlier for more and more westward sections—an arrangement by which no place will have time much more than half an hour different from sun time. Half an hour is not a matter of any great importance, as we may know by the fact that no one in the business of life recognizes the circumstance that sun time changes by more than half an hour in the course of each year in every part of the world. If we set a perfect clock or watch—that is, one steadily recording day after day 24 true hours of mean time, so that at the end of a hundred years or more it would be as near sun time as at the beginning—to show 12 noon when the sun was exactly south in February, then, tested by the sun, that clock would seem half an hour wrong at solar noon after about half a year had passed, which would *seem* to show that in a year it would be an hour wrong, and in six years would show six o'clock at 12, and in twelve years would show 12 noon for 12 midnight. Yet the discrepancy would be entirely due to a want of uniformity in the sun's motion, to which none except astronomers pay the slightest attention. In like manner, in the United States there are places where, judged by the sun (even when he is with the clock at Greenwich), the clocks seem half an hour too fast or too slow on the average all the time; yet business goes on undisturbed. The same arrangements will continue, now that the meridian of Greenwich is adopted as the reference meridian, which were in vogue before, except that possibly the American hour system may be brought into correspondence with Greenwich time instead of Washington time—so that, for instance, a traveler from England to New York, or Washington, would find his watch *exactly* instead of *nearly* five hours fast by New York or Washington time. In this way the whole world may one day be divided into hour zones, so that every change of time for a voyager traveling westward would be made by putting back his watch exactly an hour, and every change for a voyager traveling eastward would be made by putting his watch forward one hour exactly. Though, even then, at sea, the present system would have probably to be retained, by which each noon the approximate local noon is adopted.

In what, then, it may be asked, does the importance of the recent change consist? The astronomer and the geographer do not need to ask the question, knowing as they do the multitudinous inconveniences which arise from the use, in the astronomical computations, and the geographical charts made in different countries, of the longitudes of Greenwich, Vienna, Berlin, Paris, Washington, and so forth. I take up, for example, in the old time of the controversy about the transit of Venus, a treatise or paper written by Puiseux at Paris, or by Newcomb at Washington, and I find that before I can compare properly the results deduced or discussed by the French or American astronomer with my own, or with others dealt with by English astronomers, I must translate the French or American longitudes and times into Greenwich longitudes and times. Even in the case of a single treatise, the time thus wasted (there is no other word for it) is considerable; but when a great number of such works, on different astronomical subjects, pass through an astronomer's hands weekly or monthly, as is the case with me, the nuisance becomes quite serious; and when we remember that this is so in the case of one person alone, we see how large the total waste of time and trouble thus arising must necessarily be.

The geographer is similarly annoyed. In comparing French, German, or American maps with English maps, or geographical statements by geographers of other countries with similar ones made in England, the geographer finds that every detail depending on longitude has to be corrected or translated before the full significance of the foreign charts or statements can be appreciated.

In fact, this question of a meridian of reference may be regarded as affecting our view of the earth from without, as it were, more importantly than the view we take of the earth as residents in this or that part of her surface. It is the earth as a rotating planet which has now been definitely marked for reference, so that all astronomers and all geographers measure from one and the same mark, not each set from a mark of their own. Just as astronomers use a fixed meridional marking on Mars by which to time the rotations of the planet, so in future will astronomers and geographers act with regard to the earth. Strange that they should have assigned a fixed meridian to a planet many millions of miles away, many years before they assigned a fixed meridian to their own planetary home!

It may be asked whether the adoption of a fixed meridian for the whole earth will affect the question many find so perplexing, as to what day of the week it is at particular places, and at particular times. Here it is to be noticed that the usage of astronomers and the usage of business folk must of necessity differ. To the astronomer there will now be, what hitherto there has not been, a definite series of days, the same all over the world. What people in England call, for instance, November 17, viz., the interval of time between midnight and midnight on either side of that day whose middle is noon November 17, has been for the English astronomer, and will hereafter be for the astronomers of all countries, divisible into the last twelve hours of November 16 (which ends for the astronomer at noon November 17) and the first twelve hours of November 17, whose remaining twelve hours, numbered from 13 to 24, end at noon November 18, civil time. So, all round the year—December 25, for instance, in astronomical time, will include for all astronomers, the twenty-four hours from December 25, 12 noon Greenwich mean time, to 12 noon Greenwich mean time, December 26.

But as to what day of the week it is at any particular place and time, the difficulty, which many imagine to exist only along the meridian half way round the earth, west or east of Greenwich, has always existed, and will

continue to exist, all over the earth. It is true that when we travel westward or eastward from Greenwich, we have to make a change of a full day, one way or the other, when near the meridian, which lies 180 deg. east (or west) of Greenwich. But that is only because we have not made the necessary partial change at each successive stage of our journey west or east of Greenwich. Or it might, perhaps, be rather said that small partial changes are made stage by stage in passing westward or eastward, which amount to half a day where two voyagers traveling westwardly and eastwardly at equal rates would meet; and these changes being in opposite directions, the two half days must be made into a whole day at the place where the voyagers cross each other, the westwardly voyager now taking the days (one ahead of those he had been using) of the eastwardly voyager, and *vice versa*. But the difficulty as to the day of the week exists all along, and is actually felt (which is different) wherever we pass across a line dividing two regions where different local time is used. Thus, suppose we are on a train traveling westward from New York, and pass, at half past twelve at night, a place where, along that railroad line, the change of an hour is made. It is, let us say, Tuesday morning early (half an hour after midnight) before we pass that place; but so soon as we have passed the place of change, it is no longer Tuesday morning but Monday—night—half past 11 P.M. By passing to and fro across the line of change, at any hour between 12 midnight and 1 A.M., for the eastward region, or (which is the same thing) between 11 P.M. and 12 midnight for the westward region, we can make the day of the week change as often as we please, or have any number of Mondays and Tuesdays, Tuesdays and Wednesdays, etc. (as the case may be), in the course of a single hour. But the difference of day in such a case as this is a matter of no moment, and needs no correction, whereas it would be a matter of serious moment if every one who had circled around the earth either eastward or westward remained a whole day behind or in advance of those among whom he lived. It is obvious that as the westward traveler keeps on adding hour after hour to his time, he must add a full day by the time he has gone completely round; and unless he dropped a day somewhere, he would be a day behind the friends whom he had left at home by the time he rejoined them. The opposite change must be made by a traveler going eastward; and clearly the proper place for the change is when either is half-way round; for by making it there the discrepancy never exceeds half a day.

It is noteworthy, however, that the only place where the day exactly corresponds with the Greenwich astronomical day is along the meridian just westward of but touching the meridian farthest from Greenwich. Thus, the astronomical day—November 17—runs from November 17 noon to November 18 noon (Greenwich mean time); and at a place just short of 180° west of Greenwich, November 17 also begins at noon November 17 (Greenwich mean time) and ends at noon November 18.—*Newcastle Weekly Chronicle.*

TRANSMISSION OF ELECTRIC POWER AT BIENNE, SWITZERLAND.

THE city of Bienne has at its very doors considerable

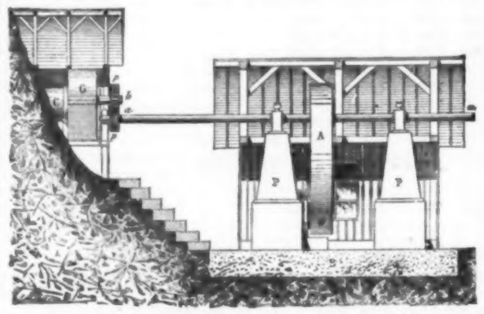


FIG. 2.—ARRANGEMENT OF TURBINE AND DYNAMO.

hydraulic power, and within its walls a flourishing industry. It was but natural, therefore, that an attempt should be made to convey power from the Suze River to the numerous clock manufactories that are scattered along its banks. Had this water course been like most others, nothing would have been easier than to set up wheels and turbines along its banks, but in view of its peculiar profile it became necessary to solve the problem in another way. In fact, the Suze, descending from the heights of the Jura as a true mountain torrent, at one and a quarter miles from the city becomes suddenly converted into a large canal with so slight a slope that it is impossible to establish the least fall therein. The entire force is found near the village of Boujeon, up stream, and for a distance of 1,000 or 1,300 feet a power of several thousand horses is available during the entire season.

FIG. 1.—CASCADE AT THE ENTRANCE TO THE GORGE OF THE SUZE RIVER.

The engraving which accompanies this article (Fig. 1) shows the entrance to the gorges of the Suze; and the great cascade seen here is but a feeble fraction of the volume of the water. This fall is the overflow from the supply of one of the turbines. The largest part of the water passes to the bottom of the gorge, but it can be easily arrested at the same level or at a level higher than that of the large cascade. A few years ago, when the question of the transmission of power by electricity was as yet not well known, the city of Bienne thought of utilizing these falls for feeding its fountains with excellent water and selling power to its industries. It therefore had a high pressure system of piping laid, and furnished water to the turbines and single-acting pressure motors of a large number of manufacturers. The first results were so advantageous that in a short time all the water that was available was sold, and even beyond; for when all the shops were working simultaneously, the loss of head became so great that the power diminished to an unwonted degree. The manufacturers, therefore, had to procure gas and steam motors as a substitute for water power, and this sometimes made it burdensome. Such was the case with Mr. Roulet, a lapidary, and Mr. Bourgeois, a manufacturer of watch cases. These two persons, tenants of the same building, began with a turbine, added to it a single-acting pressure moter, then a gas engine, and finally a steam one. This strange collection, which was very burdensome, caused them thousands of embarrassments, so these gentlemen eagerly accepted the offer made by Messrs. Bloesch and Neuhaus to furnish them power by means of electric transmission. The execution of the work was confided to the house of Meuron and Cuenod, of Geneva, who employed the Thury machine, and succeeded in obtaining an industrial duty of 70 per cent! The lessees of the hydraulic power have their works at Boujeon, at the very foot of the falls. For the moment they have but two turbines, one of large fall, fed by the water whose overflow forms the cascade shown in Fig. 1, and the other of smaller fall or head. The wooden flume shown to the right of the engraving leads the water to the latter. The locations and channels have been so arranged that two systems of turbines may be established. The available power may be easily quadrupled.

It is the high fall turbine that more particularly interests us, since that is the one that is now furnishing power to the dynamos. The volume of water available at low water is 330 gallons per second. The total height of fall is 175 feet. The turbine, which is of the Girard system, with horizontal axis, cannot, when all its orifices are open, take more than 88 gallons, and it utilizes only 150 feet of fall. It is therefore of 180 H.P. The water is let to it by a tunnel in the rock six and a half feet in depth by five in width. It will be seen that no loss of head is to be feared. Our Fig. 2 shows the arrangement of the turbine and dynamo. The water enters the turbine, G, at C. The shaft, *b*, carries along the pinions, *p*, which set in motion the shaft, *a*, that carries the pulley, A, and the belt, D, which actuates the shaft, M, of the dynamo placed alongside of pillars, P, which are firmly established upon a bed of beton, B. The little building has been arranged so that it can receive four dynamos. The large transmitting shaft continues to the right of the figures, and actuates the neighboring wire-drawing works. According to the number of wires sent into these latter, they take more or less power, and, despite an automatic regulator at the turbine, the velocity often varies 20 per cent.

The receiving dynamo is situated at about five hundred feet from the turbine. It furnishes power to two shops, which require a work varying between that of six and eighteen horses. One of these shops rolls silver, and when bars of some size are being worked the power required becomes much greater. The other shop shapes and perforates watch jewels, and requires a very uniform velocity. After some experimentation, a compound winding of the dynamos has been effected which leaves the velocity constant, whatever be the stress demanded.

The line that joins the two dynamos is an aerial one, and consists of two copper wires $\frac{1}{6}$ of an inch in diameter, carried by poles and telegraphic insulators. The two machines are of the H type. The generator revolves 500 times per minute, and gives a pressure of 350 volts. The receiver revolves 400 times, and receives a pressure of 300 volts. The diameters of the wires of the two dynamos are not the same. There is a special apparatus for starting. In fact, seeing the feeble resistance of the receiver, the generator would not prime itself. There has, therefore, been interposed in the circuit a series of brass wire spirals. The wires are inclosed in a box that carries a series of contact buttons, over which runs a strip of copper controlled by a small rack, and the latter is actuated by an endless screw. The object of this arrangement is to prevent too sudden an elimination of the resistances before the receiver has had time to get speed and develop contrary electromotive force. On turning the handle of the endless screw, it takes at least twenty seconds to pass from the maximum auxiliary resistance to the null one. In general, a few spirals of the auxiliary resistances are always left in the circuit in order to diminish, in varying degree, the velocity of the receiver. As the jewel workers have need of a variable velocity, according to the temperature of their shop, it results that a better performance is obtained from the transmission in winter than in summer.

The two extremities of the line are provided with lightning protectors—a precaution that is in no wise superfluous, since these apparatus were melted several times during the course of last summer. The position and direction of the installation, starting from a gorge and following the foot of the mountain, render it particularly exposed to lightning.

This transmission of power has been in operation for eight months. In the beginning there were a few accidental interruptions, due principally to a defect in the regulation of the brushes, but now that the *personnel* is formed, the running is perfect. Not the least traces of sparks is seen at the collector, and the operation is entirely silent.

Very accurate experiments have been made to ascertain the performance, and this we shall touch upon in another article.

This installation is peculiarly interesting because it shows a tested, practical, and industrial application to a relatively low power. May it serve as an example and as an encouragement to those numerous manufacturers who are still hesitating to apply electricity to the transmission of power!—*La Lumiere Electrique.*

PHOTOGRAPHING THE LARYNX.*

By THOMAS R. FRENCH, M.D., Lecturer on Laryngoscopy and Diseases of the Throat at the Long Island College Hospital Medical School; Consulting Laryngoscopic Surgeon to St. Mary's Hospital, Brooklyn.

IT is now more than two years ago that, with the assistance of Mr. George B. Brainerd, of Brooklyn, I made my first attempt to photograph the larynx of the living subject. The results obtained at that time were far from satisfactory, yet we were encouraged to continue our experiments, and, though meeting at times with difficulties which seemed almost insurmountable, these experiments have finally been brought to a successful termination. Our object has been not only to obtain good photographs, but to devise an easy method by which any expert laryngoscopist can photograph the larynges of his patients in every-day practice. This we have accomplished.

The assistance rendered by Mr. Brainerd has been invaluable. This gentleman, who is an extremely skillful amateur photographer, is a civil engineer by profession, and his interest in this work has been purely of a scientific character. He became interested in these experiments while under my care for the treatment of an acute affection of the larynx, nearly two years and a half ago. Having volunteered his services, he entered into the work with great enthusiasm, which has continued unabated until the present time.

Prior to the beginning of our experiments, though many had tried, all had failed to produce a good photograph of the larynx. Since then Mr. Lennox Browne and Mr. Emil Behnke, of London, have been successful in obtaining some excellent photographs of Mr. Behnke's larynx. In a paper on "Photography of the Larynx and Soft Palate," by Mr. Lennox Browne, read at the annual meeting of the British Medical Association, held in Liverpool, August, 1883, the writer says: "I do not anticipate that photography of the larynx can be extended beyond the boundary of physiology. To expect photographs from life of pathological conditions is plainly unreasonable, since those we have seen could only have been obtained by elaborate and costly machinery, and, above all, from a subject possessed of unusual, indeed, in my experience, of unequaled

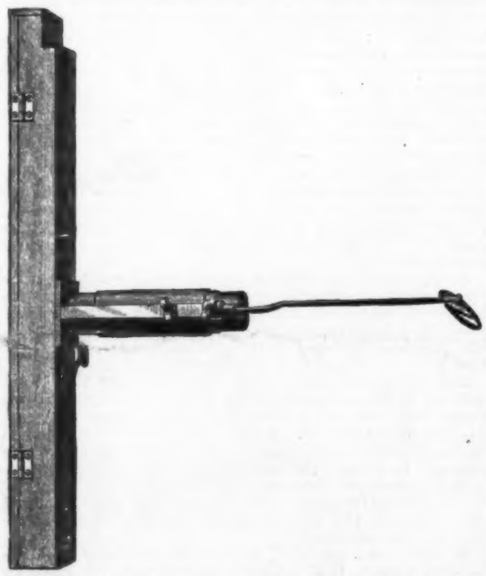


FIG. 1.—CAMERA FOR PHOTOGRAPHING THE LARYNX.

knowledge of what was our goal, and skill and endurance necessary for its attainment." I make this quotation to show how great were the difficulties which presented themselves to one who had been successful in obtaining some very good photographs of one subject.

Not only have we succeeded in devising a method for photographing the larynges of those accustomed to the presence of the mirror in the fauces, but, as some of the photographs in Portfolio 1 will show, of those upon whom the laryngoscopic mirror was used for the first time, and who were ignorant of the object of the procedure. Allowing that the fauces are moderately tolerant, with the method which I am about to describe there is, as a rule, no greater difficulty in obtaining photographs of pathological than of normal conditions.

Not only can the larynx be photographed, but it can be done with ease and without assistance. Five minutes are enough for the preparation and arrangement of the instruments, and in another five minutes from three to five exposures may be made; so that, after one has become familiar with this method, allowing that the instruments are ready for use, not more than five minutes will be needed to secure a good photograph of the larynx, which can afterward be developed and printed at leisure.

The obstacles encountered in bringing this method to its present state of perfection were both numerous and great. The first difficulty we met was with the camera. The stationary camera was found impracticable, for reasons which must be apparent to all. This difficulty was overcome by devising a small camera which could be held in the hand while the photograph was being taken. The next difficulty which presented itself was the source of illumination. Plain sunlight was not powerful enough; the oxyhydrogen light did not give good results; the arc electric light used with the reflector was not satisfactory; and direct illumination with a modified "photophore électrique frontale" of Trouvé, of about twenty-candle power, was only strong enough to make a faint impression on the most sensitive plate. This difficulty was surmounted by a device for use with sunlight, which will be described hereafter. It being necessary, in order to obtain sufficiently large pictures for practical purposes, to place the lens of the camera close to the mouth of the subject, another difficulty was encountered in the condensation of the vapor of the breath upon the lens, and so obscuring or blotting out the impression.

This was overcome by placing a diaphragm in front of the lens, which not only prevented the lens from becoming fogged, but also increased its focal depth.

In order to illuminate and expose the entire larynx in the throat mirror, it was found necessary to use a mirror with a slight convex surface, the illumination being sufficiently strong to allow the loss of light occasioned by the dispersion of the rays from the convex mirror.

The minor difficulties encountered were too numerous to mention; suffice it to say that all have been overcome. About fifteen hundred exposures were made before satisfactory results were obtained.

The apparatus for photographing the larynx, which I now take pleasure in presenting to you, consists of (1) an instrument which I shall term a sunlight concentrator; (2) a camera with throat mirror attached; and (3) a perforated forehead reflector. The sunlight concentrator consists of a hollow truncated cone of metal, ten inches long, in the large end of which is a double convex lens five inches in diameter, which has a focal length of thirteen inches. At the outer end of a short movable tube, fitted into the small end of the cone, is a plano-concave lens of 1⅞ inches diameter, with its plane surface outward; this is placed an inch or so inside of the point of focus of the double convex lens, and in that position intercepts the converging rays and makes them parallel or divergent, according to its distance from the first lens. With this device a powerful light is obtained, and that, too, without material heat. The cone is mounted on a rod by means of a universal joint, the rod being fastened to the frame of a window into which the sun shines.

The camera (Fig. 1) consists of a box 10½ inches long, 1½ inches wide, and ⅞ of an inch in thickness. The back opens upon hinges, and allows the introduction of the ground glass or plate-holder. The plate-holder is long enough to admit of five pictures being taken. On the front face of the camera a telescopic tube 3¼ inches long, when run out to its full extent, is attached, and at the outer end of this tube the lens is placed. The lens is made up of two achromatic meniscus lenses of one-half inch diameter, and has a focal length for parallel rays of 1⅞ inches. In the front part of the camera is a narrow compartment in which slides a drop-shutter of hard rubber. The shutter is released by means of a key on the front face of the camera. At the side of the tube holding the lens is a hollow handle of brass, into which the shank of the throat mirror is passed and fixed by a thumb-screw. The shank is attached to the right side of the frame holding the mirror. The object of this is, mainly, to allow of the lens being held opposite any part of the opening of the mouth. I have already stated that the mirrors used are slightly convex, the radii of their spherical surfaces varying from twelve to twenty-four inches, twelve inches radius being as small as can be used without danger of distortion.

The manner in which the apparatus is used in taking photographs of the larynx is as follows:

I have here a sketch (Fig. 2 shows sketch reduced) which will, perhaps, aid you in understanding the description. A concave reflector attached to a head-band is so arranged over the left eye that the beam of sunlight will be received upon it and thrown into the mouth of the subject. It is important that the beam of light should be thrown from the inner side of the reflector, that nearer the nose, for in this way the angle between the reflected beam and the axis of the lens is reduced to a minimum. As a rule, the tongue must be protruded and held well out between the thumb and forefinger of the subject's right hand, though in exceptional cases the tongue may be allowed to remain in the mouth. The throat mirror with camera attached, held in the right hand of the observer, is now placed in position in the fauces. *The mirror and light should be so adjusted that with the observer's left eye only the central portion and left side of the larynx can be seen, and be seen to be well illuminated.*

On account of the parallax, or displacement of the image, due to the difference in points of view between the eye and lens, some skill is necessary in managing the illumination and camera, so that the parts which it is desired to bring out will be exposed to the lens if not to the eye. The image as seen by the eye is not exactly the same as that exposed to the lens. Allowance must therefore be made for this fact, the mirror being held in such a position in the fauces that a straight picture will be insured.

If, now, the tongue does not mount up above the level of the lower edge of the lens and the lower edge of the mirror, it may be taken for granted that, when the plate is exposed, the picture received upon it will be nearly the same as that seen with the left eye in the throat mirror. The plate is exposed by pressing upon the key with the index-finger; this releases the shutter, which in falling makes an instantaneous exposure, amounting, perhaps, to one-sixth of a second.

Some of the results obtained with the method just described are contained in these portfolios.* The original photographs are of about one-third the size of the larynx. Enlargements will be found opposite most of them, though the originals are very clear and distinct. Portfolio 1 contains forty-one photographic pictures of normal and diseased larynges of twenty-four subjects, and three photographs of the posterior nares of one subject.† In the laryngeal photographs the positions occupied by the various structures in phonation, inspiration, and expiration are clearly shown. In many of the photographic pictures the rings of the trachea are shown, and in one photograph even the bifurcation of the trachea can be seen. The diseases shown are: chronic catarrhal laryngitis; chronic laryngitis with hypertrophy of the mucous membrane; paralysis of the arytenoideus muscle; swelling of the tissues overlying the arytenoid cartilages in laryngeal phthisis; and papillomatous growths in the larynx.

Portfolio 2 contains four series of photographs, showing the positions of the various structures of the larynx in the production of tones in the different classes of voice. Extremely high and extremely low notes are not shown, but all of the registers of the human voice are represented. The first series shows the positions of the various parts in the production of each note in the soprano voice, from C, treble clef, first line below staff, to A, treble clef, first line above staff, while the tongue was in its natural position in the mouth, as well as while it was protruded. The second series shows the positions of the laryngeal structures in each note of the contralto voice, from D, bass clef, third line, to A, treble clef, first line above staff, also while the tongue was not protruded, as well as while it was held out.

In some of the photographs of the third series more or less mucus is to be seen in the chink of the glottis. This is accounted for by the fact that the subject was suffering from a mild attack of acute laryngitis at the time the photographs were taken. As the photographs were obtained at the last moment, the exhibition of this condition could not be well avoided. This series shows the positions of the various structures of the larynx in the production of each note of the tenor voice, from C, bass clef, second space, to A, treble clef, second space, while the tongue was held out. The fourth series shows the positions of the structures of the larynx in the production of each note of the bass voice, from E, bass clef, first line below staff, to C, bass clef, first line above staff, while the tongue was protruded.

It would be inappropriate, neither is it my intention, in this paper, to discuss the conditions which exist in the singing voice. I desire, however, to call your attention to several noticeable features to be observed in these photographs. In all of the series it will be seen that the epiglottis is not shown to be gradually raised as the voice ascends the scale. It is generally conceded that, all other conditions being the same, the higher the note sounded, the higher the epiglottis will rise. The position of the epiglottis is dependent, largely, upon the position of the tongue, and the position of the tongue varies according to the vowel sounded.

While obtaining these photographs, great pains were taken to secure the production of the same sound, the vowel ē being used in all upper notes, but, as the results prove, in a few instances I was not entirely successful. So you will observe that in some of the low notes in the series the epiglottis is shown to be as high as in notes an octave above. This, I repeat, must be attributed to the fact that the subject was not successful in sounding the same vowel in each note. Had my subjects been practiced beforehand, better results might have been obtained in this particular. There is, however, no doubt about the accuracy of the positions of the vocal bands as represented.

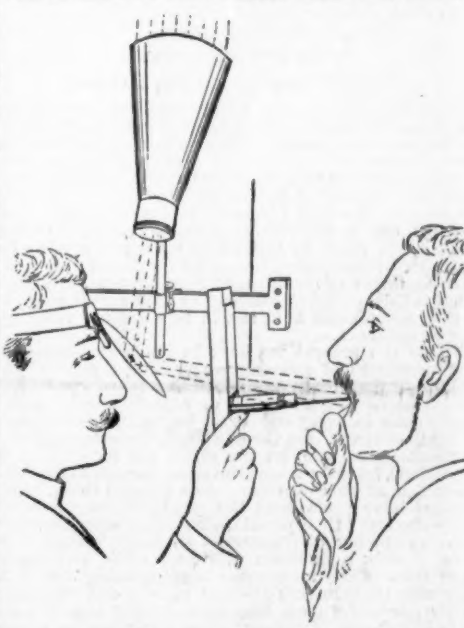


FIG. 2.—PHOTOGRAPHING THE LARYNX.

Again, it will be observed that there is very little difference in the positions of the structures of the larynx, whether the tongue was held out or remained in the mouth. In all of the series the vocal bands can be seen to be shorter, wider, and less closely approximated in the lower than in the upper notes, becoming gradually narrower and longer as the voice ascends the scale. In the lower notes of the soprano voice the chink of the glottis is widest in its posterior part, but becomes linear at about B, treble clef, third line, and continues so throughout the upper portion of the range. In the contralto voice the chink is wider than in the soprano. It will also be observed that throughout the entire range the chink is widest between the posterior vocal processes, the aperture being wider in the lower than in the upper notes. That this aperture is present in other contralto voices is shown by a photograph of another larynx, in the production of a note in the contralto voice, to be found in Portfolio 1.

In the lower notes of the tenor series the chink of the glottis is widest in its posterior part. At about B, bass clef, first space above staff, it becomes linear, and continues so to G, treble clef, first line, in which note, as well as the one above it, the falsetto mechanism may be seen to have begun. In the photograph representing the lowest note of the bass series a triangular aperture exists between the posterior vocal processes. This soon becomes elliptical in shape, and, gradually diminishing, has nearly, though not quite, disappeared in the photograph representing the highest note of the range, C, bass clef, first line above staff.

While these series of photographs of the singing voice must prove of interest, and probably of value, I do not offer them as proving conclusively the positions always occupied in the production of tones in the different classes of voice, for they are of only one individual

* Read before the Section of Laryngology, International Medical Congress, Copenhagen, August 15, 1884.

* Two portfolios were exhibited at the meeting at which this paper was read. A few of the photographs contained in Portfolio 1 have been reproduced, by the artotype process, by Mr. Edward Bierstadt, of New York, and will be found in a plate facing this article. The photographs contained in Portfolio 2 have not been reproduced, but they probably will be very soon.

† All of the photographs of the posterior nares show one or the other of the pharyngeal orifices of the Eustachian tubes. In the past few weeks the author has succeeded in photographing the membrana tympani.

of each class. Before they can be accepted they must be verified by other series of a similar character, but this, unfortunately, I have omitted to do, not having had sufficient time.

None of the photographs taken in any of our experiments have been retouched, even in the slightest degree.

While satisfactory photographs may, as a rule, be obtained at the first sitting, two sittings are sometimes required. In the first the focus is to be found. In the second, the focus being known, if all the other conditions are fulfilled, we can feel quite certain of obtaining as many good pictures as are desired.

Now let me explain to you the manner in which the focus of any subject is found. The distance from the position occupied by the mirror in the fauces to the vocal bands varies markedly in males and females, and to a less extent in individuals of the same sex. Without going into details as to the manner in which the method of focusing was arrived at, I will only state that, as a matter of fact, with this instrument, with the throat mirror eight inches from the front face of the camera, in men, with the tongue in or out, the lens must occupy a position of from 2⅜ of an inch to 2⅞ of an inch from the face of the camera. In women, from 2⅜ of an inch to 2$\frac{7}{16}$ of an inch from the face of the camera. The difference in the focus, whether the tongue is protruded or not, is about $\frac{1}{16}$ of an inch.

These figures being known, in order to find the exact focus, three exposures should be made, varying the position of the lens $\frac{1}{16}$ of an inch within the limits indicated above. By following these directions, one or more pictures of the larynx or trachea, in good focus, can almost invariably be obtained in three exposures.

If in taking several photographs of the larynx, care be exercised to vary the position of the mirror slightly, pictures may be obtained which, when viewed with the stereoscope, will present an appearance of greater depth of the cavity of the larynx than can be obtained in any other way.

I am confident that the method of photographing the larynx described in this paper is one of practical utility, and must prove of great service in facilitating the study of the functions and diseases of the larynx.—*N. Y. Med. Jour.*

THE HYPNOSCOPE.

A NEW APPLICATION OF THE MAGNET.

YESTERDAY an illusion, to-day a reality, hypnotism has definitely entered the domain of science. There is no longer any question either as to the possibility of these strange phenomena or of their high importance; it rather concerns us to increase the number of observations and determine the means of study. It is with this idea in view that I have devised a little apparatus which I call a *hypnoscope*, and concerning which I think it will prove of interest to say a few words. In truth, this little apparatus serves for discovering and, after a manner, of measuring "hypnotic sensitiveness." What is this special sensitiveness? Before it is possible to give a definition of it, it will be necessary to recognize its existence.

Up to the present we have had no suitable means that permitted of ascertaining whether a person was "hypnotizable" or not; and we have not even been agreed as to the possibility of reproducing hypnotic phenomena in every one, or in but a limited number of sickly subjects. On the one hand, the exaggerations of magnetizers, and, on the other, the incredulity of physicians, have for a long time contributed to prevent a solution of this problem. As a general thing, magnetizers have proclaimed the possibility of "making every one feel" their mystic influence, in asserting that "the producing of [magnetic] sleep, in whomsoever it be, is only a question of time," while physicians have been nearly unanimous in recognizing that it is only with those having diseased nerves, and especially with hysterical women, that these sorts of experiments have any chance of success. The researches to which I have devoted myself contradict both these assertions.

Hypnotic sensitiveness, that is to say, the faculty of being influenced by the practice of hypnotization, is neither inherent to everybody nor connected with any disease whatever—hysteria, epilepsy, neurasthenia, or anemia. It is a complex aptitude, but one *sui generis*, which depends upon peculiar reflex relations between the cerebro-spinal and ganglionary systems, and especially between the brain and the vaso-motor nerves. This special aptitude, being for the most part innate, one is hypnotizable or not just as he possesses such or such a temperament. The best of intentions, on the one hand or on the other, cannot suffice to put a person asleep who is devoid of such special aptitude.

What is the number of hypnotizable subjects? This question has been recently propounded by Dr. Bremond. "I know," says he, "97 young persons in whom all these nervous states can be produced at will. Here, at Paris, out of nine young people who belonged to liberal professions, and who consented to undergo experiment, it was found possible, in a few minutes, to put two into these nervous states of fascination, catalepsy, lethargy, and somnambulism. In what proportion are such impressionable subjects found? Who can answer the question?" This is a service that the hypnoscope is destined to render us.

According to the experiments that I have been able to perform, among persons of all conditions taken at random, the number of subjects who are hypnotizable amounts to about 37 per cent. These persons are hypnotizable in varying degree; 15 per cent. exhibit complete somnambulism, and four-fifths per cent. undergo the influence of suggestions, even in a waking state. Thirty per cent. marks a mean. The figure is lower in certain professions, and especially among physicians (about 5 per cent.). It is higher in ordinary people, in the sick, and in young persons between 15 and 25 years of age. Women are no more susceptible than men, and in spite of a certain relation with nervous diseases in general and hysteria in particular, this aptitude *sui generis* is not synonymous with nervousness. A goodly number of extremely nervous persons is not sensitive to hypnotization, while we find excellent subjects among healthy people who are in no wise nervous. Healthy women are generally less sensitive than men, while among the sick there is a marked preponderance on the side of females. Sometimes the proportion is 45 per cent. in men and 87 in women (service of Dr. Dumontpaillier, at the Hôpital de la Pitié). Hysteria seems to present a favorable field, yet there is a goodly number of hysterical women who are absolutely refractory.

And now, if this sort of a research has appeared to us worthy of attracting the attention of our readers, it is for the reason that, according to our observations, what is true for hypnotism is likewise so for the *physiological action of the magnet*. Everybody who is sensitive to the magnet is hypnotizable, and this too to a degree that entirely corresponds; all others are refractory.

Having remarked this principal fact, I have endeavored to give the magnet a form that is at once efficacious and practical. The hypnoscope is a tubular magnet, whose form (Fig. 1) recalls that of the Joule electro-magnet, only the lines of force therein are directed rather within than out of the magnetized tube. This latter is only 3·4 cm. in diameter by 5·5 in length, and weighs but 169 grammes. Forged from Alvar steel, it exhibits under this form a remarkable power, since it lifts as much as 25 times its own weight.

The mode of application is very simple. After removing the armature (Fig. 2) the forefinger of the person who is to be submitted to the test is introduced into the hypnoscope in such a way that it shall touch both poles at once (Fig. 3), and at the end of *two minutes* it is removed, and an examination made of the modifications that it has undergone. In 70 persons out of 100, taken at random, no change will be observed. In about 30 per cent. two kinds of modifications will be observed, viz., *subjective* or *objective*.

Here is where we think that we have found an answer to the question raised by Sir William Thomson in his last lecture "On the Senses of Man." Have we a special sense for the impressions of magnetism? "It is possible," says the English scientist "that there is a magnetic sense, and that a magnet of *very great power* produces a sensation entirely different from that of heat, force, or any other sensation; . . . at all events, the fact merits profound research."

In answer to these reflections, I will limit myself to the remark that in experimenting since 1880 I have

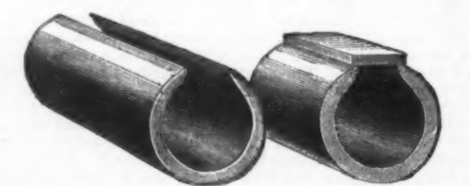


Fig. 1 Fig. 2

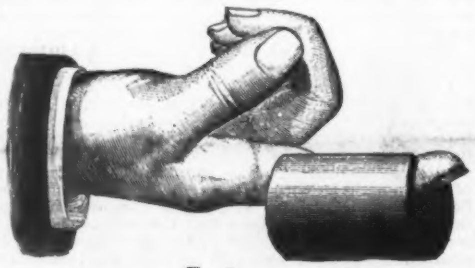


Fig. 3

THE HYPNOSCOPE.

never observed sensations that were entirely new, and as, moreover, it would be difficult to find organs for such new sense that were adapted to it, there is no ground for admitting a sixth, *magnetic* sense. But this does not prevent more than a quarter of humanity from being influenced by a magnet of medium power, and experiencing contain very distinct sensations. The principal of these are the following:

Twenty times out of a hundred, disagreeable formication and itching; and, sometimes, one would say sparks or needles pricking the skin. Seventeen times out of a hundred, a sensation as of a cold blast, or one of heat and dryness. The two impressions may coexist—one in the right arm, and the other in the left. Thus, a magnet placed under the feet of paralytics has been observed to warm them, although a good fire was powerless to do so. The cold draught much resembles that which one experiences in front of an electro-static machine.

Eight times out of a hundred there are painful sensations—pains in the joints. "I should say that my bones were being broken," exclaim the subjects under experiment.

Five times out of a hundred there is a sensation of inflation of the skin—and one which may be real, since it is sometimes difficult to remove the subject's finger from between the poles of the hypnoscope.

Two times out of a hundred there is a sense of weight in the finger or the entire arm; also a sensation of being irresistibly carried along, followed by a *real attraction*, and almost always a contraction with complete insensibility. This is an exceedingly curious phenomenon. I exhibited this experiment before the Medical Society of Lemberg in 1881. The subject (who was in excellent heath) was asleep, the eyes closed, the pupils directed upward, and the head completely covered with an opaque veil. At every approach of the magnet to within a distance of about 15 cm. his hand was quickly extended toward it, and followed all its motions until it became rigid and insensible. Then it became necessary to restore sensibility, or rather hyperæsthesia, in order to rebegin the experiments. I hasten to add that the same phenomenon was reproduced, although perhaps a little less markedly, by the approach of a metal, of glass, or of any other body whatever. The subject, when questioned in his sleep, said that he felt as if he were being carried along in a given direction without knowing why.

The *objective* modifications are profounder, and more important for diagnosis. They belong to one of four categories, viz.: (*a*) involuntary movements (quite rare); (*b*) insensibility (complete analgesia or anæsthesia); (*c*) paralysis (impossibility of moving the finger); (*d*) contractura (rigidity of the muscles).

The phenomena that are called forth disappear in a few minutes under the influence of a very slight massage; but, without that, they may persist for several minutes, and even for several hours.

Persons in whom the hypnoscope causes insensibility, paralysis, or contractura may be hypnotized in a single seance. With others the experiment must be repeated.

Let us now touch upon the question of the causes.

So it is evident that the magnet exerts a certain influence upon the nervous system of *persons who are predisposed*. This *physiological* action has been very little studied; there exists, nevertheless, a certain number of experiments relative to the *therapeutic* action. Without speaking of Mesmer, it was established as long ago as 1779 by Drs. Andry and Thouret, and confirmed by Becker (1829), Bulmering (1835), Lippic (1846), and especially by Maggiorani (1869–1880). To day it is placed beyond controversy by Messrs. Charcot, Schiff, Vogt, Benedict, Vigouroux, Debore, Proust, Ballet, and others.

But, while it is incontrovertible, is it really *magnetic*? It seems to me that it may be so admitted, in part, since (1) the importance of the action is not in direct relation with the power of the magnet, but rather with the degree of hypnotic sensitiveness of the subject experimented upon; and (2) the north pole has no other influence than the south, although it should necessarily have in the case of an action that was purely and simply magnetic. Is it, then, a metalloscopic action, as Mr. Pellot has supposed? This question, which had been already asked at the date at which I made my first communication through Dr. Brown-Sequard, I will answer as follows: (1) The number of persons who are sensitive to metals is less than that of those sensitive to the magnet, and much less than the number of those who are specially sensitive to *steel*. (2) There are persons sensitive to metals (to copper, for example) and insensible to the magnet, and consequently likewise refractory to hypnotization.

Then is this mysterious action perhaps merely purely imaginary—*suggestive*, as one says to-day after the labors of Dr. Bernheim? No; because (1) it is sometimes (though rarely, it is true) exerted unbeknown to the subjects under experiment, upon persons asleep, upon animals, etc.; and (2) we may easily distinguish the sensations produced simply by emotion or expectant attention from those produced by the hypnoscope; for imaginary sensations change character or disappear on a new test, while genuine ones always return, preserve their characters, and even become more and more marked. Imaginary sensitiveness becomes effaced, while real sensitiveness is increased by habitude.

Nevertheless, we may grant that the imagination, without being a sufficient cause to explain the phenomena, enters into play in the great majority of cases, as an auxiliary, in preparing the accessibility of the patients. In short, the influence is double—physical and psychical.

Being capable of serving as a physical excitant, does the magnet act directly upon the tissues exposed to its influence, or rather indirectly by reflex way? It appears that both cases present themselves, but that the last is the more important. It is the vaso-motor nerves that seem to be reached by preference.

Are the direct action upon the tissues or the blood and the reflex action upon the nerves identical? It appears not. At all events, magnetism alone does not explain these effects. I rather incline toward the hypothesis that, in the majority of the phenomena, the magnet is merely the substratum of another action, which is so weak, from a psychical point of view, that it hides itself from our instruments, and exhibits itself only through the intermedium of exceptionally sensitive nervous systems.

Is this other physical action due to a new and unknown force? It is probable that it is not an entirely new force, but only a new and unknown manifestation—a peculiar modification of electric phenomena. This is all that the present state of our knowledge allows us to say. But the insufficiency of theory in no wise interferes with the practical use of the hypnoscope, and, if it is true that it gives us at the same time useful indications as to the state of the nerves in nervous complaints, the importance of the application may be readily seen.

My personal idea goes still further. I see in the revelations of this instrument the necessity of a future subdivision of therapeutics. It is useless and even imprudent to apply the same remedy to sensitive and non-sensitive persons. With a large number of hypnotizable patients, all remedies are equally good or equally bad, *according to peculiar nervous influences*. We may neutralize strong doses of the most typical medicaments, and reproduce their effect in a most positive manner, by *suggestion*. In sensitive persons we obtain an improvement that is often almost instantaneous under the influence of various trifling means that hypnotism and magnetism put at our disposal.

It seems to me that we have here a line of research worthy of attracting the attention of physicists and physicians.—*J. Ochorowicz, M.D., in La Lumiere Electrique.*

OBSTRUCTION OF DRAIN PIPES BY ROOTS.

By F. A. CALKINS.

THERE are several varieties of trees that extend their fibrous roots a long distance in search of moisture, usually present in drains, and among them I have particularly noticed the following, viz.: Silver leaved maple, *Acer descarpum;* red maple, *Acer rubrum;* Elm, *Ulmus Americana.* The willow family causes more trouble than any other variety, and next in order is the elm family. In October last, when removing a tile drain in Central Park, I found the roots of a tree called *Paulonia imperialis*, which resembles the catalpa, growing in it for fifty-six feet. One-third of the length of this root was three inches in diameter, having broken a tile that was two and one-fourth inches in diameter in which it grew; the remaining two-thirds being nearly large enough to fill the tile. The small end of this root was not pointed, but circular in form, four inches in diameter and one and a half inches thick. I could discover no cause for the end to assume a circular form instead of a pointed one.

In 1871 a vitrified drain pipe eight inches in diameter,

for surface drainage only, was laid under my direction in Madison Square; located from seven to fourteen feet distant from white willow trees, *Salix alba*. The mortar used in making up the joints of the pipe when laid was composed of equal parts of Rosendale cement and sand. Three years after, in 1874, this drain pipe was found to be partially obstructed; and an effort made to force an opening with stiff wire met with only partial success. The following year the pipe was taken up, and found completely filled with fibrous roots growing from the willow trees; and so compact had the mass of roots become that a horse attached to one end removed a piece sixty feet long. The roots composing this mass varied in size from one-sixteenth to one-fourth of an inch in diameter; and the proportion I found to be as follows: fibers one-sixteenth of an inch in diameter composed thirty per cent.; fibers one-thirtieth of an inch in diameter, sixty per cent.; fibers one-fourth of an inch in diameter, four per cent. The mortar used in cementing the joints of this pipe was in perfect condition, and no cracks were discovered to allow the roots to enter the pipe, but a closer examination revealed the mystery. The fine fibers, one-sixtieth of an inch in diameter, had grown through the solid mortar, and increased within the pipe to the size and length described.

This drain was then relaid with similar mortar joints, but the roots still continued to obstruct the pipe, making it necessary to remove it in 1877, 1879, and 1881.

When this drain was relaid for the third time, in 1881, I recommended bituminous paving cement to be applied to the joints after having been prepared in the usual manner with mortar, to prevent if possible further trouble from roots; but they obstructed the drain for the fourth time the present season, and when the pipe was removed, about twelve feet of it was found filled with roots, which entered at only a few joints, where the mortar had been imperfectly covered by the cement with a thin coat painted over the mortar joints. Wherever the cement was soft the roots grew through it, but were killed; wherever the coating of cement was only one-eighth of an inch thick but hard, it killed the roots but was not penetrated by them. I tested roots that grew through the soft cement, with a microscope, and also placed them in water of a mild temperature, where they remained for two weeks without any sign of vitality appearing.

This drain was relaid again in July last, and I then treated it in a thorough manner with a bituminous concrete, which will now be described. When relaying the pipe this season, the sockets only were filled with mortar, in order to present as little mortar surface as possible to be covered with the concrete, preferring to apply the concrete on the glazed surface of the pipe rather than on the mortar. The bituminous concrete was composed of N. Y. Coal Tar Chemical Co. paving cement, known to the trade as No. 5, mixed with fine gravel; No. 4 paving cement and fine sand would have been preferable—the proportions used being seven gallons of paving cement to forty cubic feet of fine gravel. This proportion should be varied according to the fineness of the gravel or sand. The paving cement and gravel were heated separately to about 220° Fahrenheit; then thoroughly mixed, and applied at a temperature of 200° Fahrenheit. Before applying this mixture the pipe was painted with crude coal tar without heating, to make the concrete adhere more readily to the pipe. The tar can be applied with a brush or rag tied on a stick. The concrete was then put on around the joints not less than three inches in thickness, extending four inches each way from the ends of the hubs, covering the surface at each joint eight inches longitudinal of the pipe, the ground having previously been dug away from under the joints and pipe for less than three inches. This concrete was packed thoroughly around the pipe by ramming with wooden rammers. Great care should be taken to pack the concrete thoroughly while warm. No filling of the trench should be done until after the concrete has become hard. This concrete was applied to the drain for seventy feet, with manholes at each end to enable it to be readily examined in the future.

The partial success obtained in the first imperfect trial has induced me to believe that the latter experiment will be successful; and also that the carbolic and cresylic acids, naphthaline, and the basic oils contained in the paving composition, when applied in the manner described, will effectually prevent the ingress of any roots into drains. Time will determine whether my conclusions are correct.—*Engineering News.*

A GROUP OF CACTUS IN JAMAICA.

IN the temperate zones, although some species of the cactus are known, like that of the *nopal* in the Mediterranean region, which is the *Opuntia vulgaris*, there is little idea of the powerful development which these singular plants acquire in the tropics, especially in equatorial regions. The *cactaceas*, so named by the modern botanists, until within the last two years constituted only relatively one genus, and its different species were not well defined; but later discoveries made in the Antilles, Ecuador, Guatemala, and other South American countries have led naturalists to constitute a family divided into two tribes according to the form of their flowers, and subdivided into various classes whose names are *mamillaria*, *melocactus*, *echinopsis*, etc., belonging to one genus, and *rhisalis*, *opuntia*, and simple *nopal* to the other.

In Jamaica these plants acquire gigantic dimensions, while between their prickly spines they throw out solitary flowers, large, beautiful, and of most vivid colors, which perish in a few hours.

Recently we have received the photograph which we reproduce in our engraving. It represents a group of colossal cactus in the interior of Jamaica, and shows a fair sample of the powerful vegetation of this tropical country.—*La Ilustracion Espanola.*

A GROUP OF CACTUS IN JAMAICA.

ICELAND.

By J. STARKIE GARDNER, F.G.S.

THE utter disappearance, with the most trifling exceptions, of the dwellings and even public buildings of the Anglo-Saxon period, which must have been one of relatively high civilization, has been a subject of wonder to moderately well informed people like myself.

I had the opportunity a short time since of traversing Iceland in many directions. The country is civilized, and has a history in many respects like our own, yet nowhere was the slightest trace of any occupation to be seen. A brief note of the more salient points in its early history will render apparent how closely its civilization must have resembled our own in Saxon times; and if the styles of building were equally similar, we shall be at no loss to understand why no traces of them remain.

Iceland was colonized in the middle of the tenth century, and so rapid that Harold, in order to check its too rapid growth, imposed a fine of four ounces of silver upon all immigrants. A Saxon bishop arrived in the year 981, and in 984 the first church was built. In A.D. 1000 the whole country was converted to Christianity; Benedictines and Augustinians settled, and a tribute was paid to the Roman See. It was not until 1261 that the inhabitants put themselves under the protection of Norway, and there is every reason to believe that prior to that date their civilization equaled any which obtained among their relatives settled in England. Their manners, customs, mode of life, were probably identical, and of these their scalds have left an almost uninterrupted record from the golden age of Harold, *aux beaux cheveux*, to late historic times. We have, in addition to direct evidence that these have never undergone much change, collateral evidence to show that the habits and customs of the population are still substantially the same as they were in the tenth and eleventh centuries. The ordinary Icelander has no towns and no centers of reunion; he lives alone, whether priest or peasant, and when he meets his distant neighbors it is by accident. The people, though nominally under Denmark, have never been called on to supply either soldiers or sailors to the Danish services, and until quite lately no one ever thought of wandering outside his native land. There are even now no roads or bridges, and the country consists entirely of narrow valleys, separated by mountains or hills averaging 1,200 to 2,000 feet high, each valley being the bed of a torrent, often difficult and even dangerous to ford. The Norse language, which was carried to Iceland by the colony of noble families who first settled there, was spoken with conservative elegance, free from any mixture of foreign idiom. While, in course of ages, it became modified on the mainland, it was preserved in the interior of Iceland in all its native purity, so that even as early as in the twelfth century the language of the ancient sagas was spoken of as Icelandic. Under the primitive conditions and habits obtaining in this isolated country, it has remained undefiled and pure, indeed there is no priest or peasant at the present day in Iceland who cannot understand perfectly the language of even the most ancient of the sagas. The relationship between modern Icelandic and the Saxon element of the English language is still to be traced, for, though marked by wide divergences of spelling, a great number of common words, when slowly pronounced, can be mutually understood, and a glance at the names on a map will indicate the kind of community that exists. Another example of the small amount of change that has taken place in the habits of this people is seen in the collection of native work in the museum at Reykjavik. The wood-carving, and more especial-

ly the needlework, would not, from its style, be assigned to a later date than the twelfth century, yet much of it has been executed in, and is actually dated of, the eighteenth century. Patterns originated in the days of Harold, and used in the Bayeux tapestry and contemporary works, have been faithfully adhered to, and handed down from generation to generation without the smallest change in style. The costume of an Icelander even now, except at trading stations, is of homemade frieze of a uniform brownish tint. The women display a somewhat greater variety of color, but all alike wear a peculiar black fez cap and long tassel. They have a gala dress, handed down as heirlooms in families on account of its costliness, the head-dress of which is a small white Phrygian bonnet, the lapel of which is stuffed and stiffened like the crest of a helmet, decorated silver frontlet and ornaments, from which depends backward a long lawn or lace veil. This dress must be of extreme antiquity. Other instances of the conservancy of the Icelander might be adduced were it not almost superfluous to do so here, the dwelling house being the point in view. The probability is great that the Icelander has been as conservative in the plan and build of his dwelling as he has been in his language and his art.

Nothing can, in fact, be well imagined that could have modified it, for Iceland remained so isolated until the introduction of steam, that when Sir Joseph Banks, P.R.S., visited it toward the close of last century, money was almost unknown, and traffic was entirely carried on by means of bartering coarse home-spun cloth, dried fish, etc.

The typical Icelandic house, or *bær*, as it is termed, is constructed either entirely of earth or of earth and rough stones in layers, and has a turf roof, made waterproof by a lining of birch bark or straw. It is far, however, from a mere earth cabin, and has an intricate arrangement. Very little wood is used in its construction, as the country is destitute of timber, for it is not only costly but difficult to transport from the seaports in a land where any approach to a wheeled vehicle is unknown, and the balks or logs have to be dragged over mere tracks at the heels of the sturdy little ponies through whom locomotion is alone possible. The rafters and lintels, however, are of wood, obtained somehow, and the floor of beaten earth. A well arranged dwelling consists of seven houses side by side, each under its own peat roof, and with walls four or five feet thick. Those toward the center are the largest and loftiest, consisting of two floors, with one room to each. These are the dwelling rooms, and possess but one door in common. The entrance opens on to a dark and low ante-room (*bæardyr*), on the left of which is the guest chamber (*gestaskali*). The inmates usually sleep in lofts under the roofs, reached by ladders, and sometimes situated over the cow-house for warmth. Not infrequently, however, the dwelling room (*badstofa*) is in rear of the other buildings, and is reached by a long dark passage 50 to 80 feet in length. It is a large and gloomy apartment lighted only by small holes in the side or roof, around which turf bunks are arranged, as in emigrant ships, in which the family and servants of both sexes sleep. The kitchen is a much smaller apartment, some flat stones on the ground serving as a stove, while a hole in the roof, with the sides carried up to promote draught, acts as window and chimney. The kitchen may be on the right of the ante-room or in rear, and there may be two state rooms in front, though this is very rarely the case. The bed in the guest chamber occupies a niche in the wall facing the front window. The low house at one extremity is the cattle shed, and at the other a storehouse or smithy. A dairy and store or tool house complete the row, these latter being windowless, while the guest room is provided with a small glazed window. In the better class of priest's or farmer's house, and every priest is a farmer save on Sunday, one room at least is wainscoted, and it is obvious that wood would be less a luxury if its cost were brought within the means of the builders. With this exception, the Icelandic house described may differ but little from that inhabited in England by the well-to-do Anglo-Saxon farmer up to the Norman invasion. The absence of any stove or fire, except in the kitchen, leads to the exclusion as far as practicable of the outer air and a crowding together for the sake of warmth. The smoke in the kitchen is generally beaten down into the apartment, and the odor is very unpleasant and everything exceedingly dirty. In the matter of keeping out wet, the Icelandic building also leaves much to be desired. Externally the frontage, if boarded, as is sometimes the case in more recently erected buildings, is rather imposing; but the simpler and smaller houses, mere cabins, may be almost ridden over unintentionally when descended upon from the slope of a hill, owing to their grass-green roof and low elevation. Every farm stands in an inclosed piece of ground, surrounded by low turf walls called the tun, or town, which provides the winter's hay, while elsewhere cattle and sheep seem allowed to browse at will.

There are, of course, stone buildings in the capital for the use principally of the Danish officials; the Danish trading stations are ordinary wooden houses. Here and there a rich man, who has combined trading with farming, has had a complete house shipped from Europe; but these have all been erected recently, and are so exceptional that there are probably not half a dozen over the entire island, whose area is somewhere about the same as Ireland. There is nowhere any trace of the ruins of ancient buildings, and the only piece of old masonry existing seems to be the circular bath of Snorri Sturluson, the celebrated saga writer of the thirteenth century. The older churches are of turf and wood, and of no architectural interest, though sometimes gaudily painted inside. There are no other public buildings, and even the Icelandic Parliament was held *al fresco* in the historic plain of Thingvallir, the deputies being housed in tents.—*The Architect.*

UNDERGROUND WATER AND THE MOISTURE OF THE SOIL.

By FR. HOFMANN.

THE author contends that, in order to understand the distribution of moisture in the soil, we must distinguish three strata which differ in their power of receiving and giving up water. The upper layer, or "evaporation zone," depends on the weather, and is exposed to the greatest fluctuations in its proportion of moisture. After persistent drought it may take up the entire rain of six or even twelve months, so that not a drop passes into the lower strata. This zone is the more important in a sanitary point of view as it is exposed to contamination from above, to the direct invasion of pathogenous fungi, and to both the highest and the lowest temperature. The middle stratum, which the author terms the "transit zone," has a tolerably constant proportion of water, depending on the size of the soil capillaries. Evaporation has no influence upon this region, and an influx from above modifies its proportion of moisture only in so far as the water which penetrates it traverses the capillaries more or less rapidly according to their size. According to the thickness of this stratum, its quantity of water may be very considerable, equal to the downfall of several years. The lowest stratum is called the zone of the capillary groundwater level. It begins at the surface of the subterranean waters, and its moisture depends on the nature of the capillary intervals. The author concludes that all impurities, organic or inorganic, placed upon the surface remain in the upper zone, and cannot be washed down into the subsoil waters, even by heavy rains.

WATER METERS.

THE Minneapolis *Tribune* gives the following list of rates for metered water per gallons:

	Cts.	Cts.
Meriden, Conn	10	to 25
Boston, Mass	20	to 30
Lawrence, Mass	20	to 20
Taunton, Mass	12½	to 25
Springfield, Mass	15	to 30
New Bedford	12½	to 15
New York City	20	to 35
Albany, N. Y	10	to 40
Newark, N. J		to 15
New Haven, Conn	15	to 30
Worcester, Mass	15	to 30
Utica, N. Y	25	to 50
Titusville, Penn	12½	to 30
Syracuse, N. Y	20	to 40
Schenectady, N. Y	20	to 50
Rochester, N. Y	10	to 50
Providence, R. I	20	to 30
Pawtucket, R. I	6	to 30
Portland, Maine	30	to 50
Oswego, N. Y	20	to 40
New London, Conn	20	to 30
Hartford, Conn	16	to 30
New Britain, Conn	10	to 30
Jersey City	10	to 20
Burlington, Vt	20	to 50
Dayton, Ohio	15	to 50
St. Paul, Minn	25	to 50
Cincinnati	15	to 15
Detroit	20	to 20
Brooklyn	25	to 25
Minneapolis	10	to 20

AN ABSOLUTE STANDARD OF LIGHT.

IT will be remembered that during the Paris Electrical Exhibition of 1881, M. Violle suggested as a standard the light radiated by a square centimeter of platinum at the fusing point, or in other words, at its point of solidification. The Congress which then sat recommended the Carcel lamp, of the Dumas and Regnault type, as a secondary standard, and the International Conference has now definitely adopted the Violle light as the primary standard. M. Violle has since determined the value of the Carcel lamp in terms of his proposed standard. By different methods he finds the normal value of the Carcel "bec" is $\frac{1}{2\cdot08}$ of the platinum standard; and surface for surface, the intrinsic light of the latter is about eleven times greater than that of the Carcel flame. M. Violle has also compared his standard with electric incandescent lamps, which from their color and constancy are easily compared with the platinum light. A Swan incandescence lamp was fed by thirty Kabath accumulators; a resistance box being inserted in circuit to regulate the current. Every minute an observer noted the current strength, i, and the fall of potential between the terminal, e, and the photometric values of the light were also determined. Comparison between the electric lamp and standard was effected by means of a Bunsen photometer having a range of 4 meters. The rays of the platinum emitted vertically were bent horizontally by means of a mirror at an angle of 45 deg. For eighteen experiments the value of the light reflected from the mirror was found to be 7·023 carcels. The normal carcel was found by this method to be $\frac{1}{2\cdot07}$ of the light reflected, which agrees well with the prior value. The experiments led M. Violle to the conclusion that the platinum at its fusing point fulfills the conditions requisite in an absolute standard of light, resting as it does on a definite physical phenomenon. The standard chosen is readily comparable with existing standards, and the unit can be multiplied by increasing the surface in fusion.

REDUCTION BY ELECTROLYSIS.

M. NIAUDET has recently been experimenting with some success on the reduction of chloride of sodium, or common salt, into its components, chlorine and sodium, by means of the electric current; and as both of these products are very valuable, the former for bleaching, the latter for chemical purposes, it is to be hoped that his further experiments will be crowned with perfect success. Mr. Sommer, a Californian electrician, has also devised a method of reducing lead from its ores by electrolysis. Salts of lead in solution submitted to the electric current yield a deposit of lead on the negative electrode and peroxide on the positive electrode. Mr. Sommer arranges to amalgamate the lead before it oxidizes or deposits. His process consists in placing a layer of mercury in a glass test tube (20 to 40 grammes), then a quantity of dilute chlorhydric acid (15 to 20 per cent. of H. C. L.). Into the tube is then placed a gramme of lead ore pulverized, which falls to the surface of the mercury. An electrode of lamp carbon is then dipped into the mercury, and one of graphite into the acid. The current of four Daniell or Meidinger or two Bunsen or Grove elements passed through the combination, while the test tube is kept at 70 deg. Cent., serves to effect the reduction. Sulphureted hydrogen is disengaged at the negative pole, and hypochlorous acid at the positive pole. At the end of five hours the reduction is complete, and the mercury being taken out, washed, and weighed, shows that the lead has been amalgamated. It is necessary to have the positive electrode of graphite and the negative of lamp carbon.

THE LIQUEFACTION OF GASES.

DR. D. TOMMASI.—The author has come upon the following passage in the *Antologia di G. P. Viesseux* (vol. xxvii., A.D. 1827): "Perkins has submitted water and other liquids to powerful pressure, employing a bronze cylinder in which worked a steel piston. The cylinder was 34 inches in length; its internal diameter is 1⅛, and its external diameter 13¼ inches. The greatest pressure exerted by means of this apparatus was 2,000 atmospheres. Compressed air in contact with mercury began to be liquefied at 500 atmospheres; at 1,000 atmospheres the mercury filled two-thirds of the space previously occupied by the air, and small liquid drops began to appear. At 1,200 atmospheres there was seen over the mercury a transparent liquid occupying $\frac{1}{100}$ of the space previously taken up by air. Ethylen began to be liquefied at 40 atmospheres, and at 1,200 it was entirely reduced to a liquid." Dr. Tommasi raises the question whether the air operated on by Perkins was absolutely dry.

A CATALOGUE containing brief notices of many important scientific papers heretofore published in the SUPPLEMENT, may be had gratis at this office.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
361 Broadway, New York, N. Y.

TABLE OF CONTENTS.